THE AMERICAN GAS LIGHT JOURNAL

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME LV.—No. 2. Whole No. 840. | NEW YORK, MONDAY, JULY 13, 1891. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
JOS. R. THOMAS, C.E., Editor. T. J. CUNNINGHAM, Asst. Editor.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y. AS SECOND CLASS MATTER.

Published on each Monday of the year, at No. 32 Pine Street, N. Y.

Terms of Subscription, Including Postage.—For the United States and Canada, $3 per annum. European countries, $4.50 (19 shillings—22½ francs). All payments to be made in advance. Single copies, 10 cents.

Remittances should be made either by post-office order, express money order, registered letter, or bank draft on New York, payable to the order of A. M. Callender & Co.

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BRIEFLY TOLD.

A SIGN OF THE TIMES.—The agitation for the control by municipalities of the artificial lighting supply of cities and towns has brought out one fact, if no other, that is striking in force and odd in effect. Nor can we say that it is altogether in favor of the theories of the purists who advocate such control. The mainspring that actuates all business seems to depend for its pulsation on one's ability to keep it in taut motion, at the expense of others—an admission that your purist will never voluntarily make. And this leads on to the remark that the advocates of municipal control are never weary of setting forth their palaver by introducing the same with the intimation that their uppermost desire is to secure the greatest good for the greatest number. The trouble about this, however, is that one is apt to predicate the future on the past; and a rather sensible method it is to follow, remembering that the plan has so often borne its fruit of reality. The Bellamyites reverse this system, in substance, although they claim to be "looking backward," in order that their future strides may be made over improved ground. They tell us, when speaking of gas supply, that gas companies have received great nubs of favor in the shape of "rights" to occupy the streets—at a depth of a certain number of feet and inches from the pavements. And, if we mistake not, this is about the full measure of the State's "favor" to a gas company. In the meantime the State, through its sectional representatives, has the right also to occupy the beds of its streets, and it does so, without regard to any other tenant. Sometimes it is dilatory in taking up its claim; as, for instance, when a sewer is to be put through a street at a time after—years it may be—the gas mains had been put down to supply gas to public lamps that the authorities decided were necessary to light wayfarers to their homes between the gaps that will occur in the development of cities. To put the latter part of this a trifle plainer: The gas company was lighting the sidewalks, for the comfort and safety of the inhabitants, in certain sparsely populated districts, when the city refused, or neglected at any rate, to put sewers in the same districts, on the ground that the districts did not house a sufficient number of people to warrant the expense of draining the territory—it should be borne in mind that professors of sanitation and looking backwardism are loud-mouthed, too, in calling attention to the belief that cleanliness is next to Godliness. And we take it for granted that even Bellamy will admit that drains are great aides to the keeping clean of a city. In due time, however, the gaps between the populated districts lessen and the authorities decide that drains must be pieced out and woven into the general drainage system of the place. We will say that a pretty close friend of the "Chairman of the Sewer Committee of Councils" secures the contract for the aforesaid piecing out process, and that the lucky contractor is favorably thought of by the City Surveyor or other officials in charge of the grades of the streets, and so on. It so happens—there were no "official" grades to the street lines when the gas pipes were laid—that the sewer is to be laid within a few inches of the gas pipe line, and then the trouble begins—that is, trouble for the gas company. The sewer digger and his men slash right and left, regardless of results, and the latter are always unfavorable to the gas men. Not only unfavorable, but very costly. Mains are broken, joints are strained and services are snapped. In fact, we have recently heard of a case, that will likely soon occupy the attention of the courts, in which a contractor

engaged in excavating work on account of the city, deliberately drew a wide, flat shovel—drawn by horses—over and to one side of a line of gas main with the result that a score or more service pipes were destroyed. Of course, all this is not new by any means to the gas makers of the country, but it will serve to call attention to the fact that the "privileges" enjoyed by gas companies underneath the streets are more fancied than real, when it comes to a question of tenant right damages. Again, we may take heart of hope in that the companies seem no longer disposed to accept these occurrences in the meek spirit that, as a rule, has heretofore characterized them, but will demand redress. Notable instances of this determination are afforded in the damages claimed at Mount Vernon, Ohio, and Houston, Texas, on account of unwarrantable interference and injury on the part of the authorities to gas mains at the points noted. It is true that the amounts involved are comparatively small, but they are large enough in point of effect. If the gas companies are tenants of the city's streets, and are to be held accountable as such, they are certainly entitled to the redress that the common law affords to every tenant when his rights have been infringed.

CHEAPER GAS FOR MADISON, IND.—Mr. H. B. Foster, President and Secretary of the Madison Gas Light Company, writes us that on and after October 1st, next, the net rates for gas will be as follows: For illuminating purposes, $1.90 per 1,000 cubic feet; for fuel purposes, $1.40 per 1,000 cubic feet. All of which goes to show that the proprietors of the Madison Company are in the field for more business.

THE FLEMMING FURNACE GROWS IN FAVOR.—The following list of orders furnishes proof that the Flemming Generator Gas Furnace grows steadily in the favor of gas men: 12 benches of 6's, at Brookline, Mass.; 8 benches of 6's, at Worcester, Mass.; 4 benches of 6's, Northern Gas Company, N. Y. city; 2 benches of 6's, at Sing Sing, N. Y.; 2 benches of 6's, at Georgetown, D. C.; 1 bench of 6's, at Dunkirk, N. Y.; 1 bench of 6's, at Northampton, Mass.; 1 bench of 6's, Central Company, N. Y. city.

IF the General Committee on the coming World's Fair at Chicago has determined to relegate gas to a subordinate position in the matter of lighting the buildings and the like at the grand show, it is an equally positive thing that the Chicago City Councils are just now having a very busy time of it in passing upon applications for ordinances for the establishing of gas works in that city in opposition to the Company that now holds the field. No less than three sets of said-to-be capitalists are anxious to have a try at the general gas supply of the Windy City, which looks as though gas was not to be out of the running there for some time to come. This mention recalls to mind an editorial in the last issue to hand (June 30th) of the London *Journal* that deals with the subject of "Gas at Exhibitions," and which was inspired by the news that the Chicago exhibition authorities had determined to overlook gas as far as possible in the lighting of the buildings. Having referred to the part taken at the last Paris Exhibition by the French Gas Companies, our contemporary remarks: "It is not to be supposed that the gas industry of the United States will be affected in the least, whether or not a single gas flame is seen burning in the Chicago Exhibition. The part to be taken by makers of gas apparatus in the show is another consideration. The manufacture of such appliances is a flourishing American industry, and ought therefore to be duly represented at Chicago. With regard to gas itself, however, we have the idea that the public use it for the same reason as they consume wheaten flour—they cannot do without it."

The Market for Gas Securieties.

During the week dullness reigned supreme in the local stock market, but gas shares, although neglected, nevertheless showed some strength. Consolidated to day (Friday) opened at 93 to 94, yet listlessness ruled. Equitable and Mutual are steady to strong, and some inquiry was made for Standard. Since the first of the month rumor has had it that an important deal may shortly take place in city gas matters, and the gist of the story is that a consolidation of the interests of the Equitable, Mutual and Standard Companies has been suggested. We give the rumor for what it is worth, and nothing more. Over in Brooklyn the gas share market is quiet, with an inclination to weakness, save in respect to Nassau, a sharp advance in which—some 4 points in the bid rate—is reported. Chicago gas is at 50, the weakness in same no doubt being chargeable to the passage by the City Councils of the ordinance asked for by the promoters of the Economic Gas Company. The certificates of "Equitable interest in stocks of the Chicago Gas Companies" are now ready for exchange for the old certificates. The former will be recognized by the Stock Exchange as a "good delivery." The Laclede shares are quoted at 13¾ to 14. The Milwaukee Company has declared a semi-annual dividend of 5 per cent.

On the Effects of Specific Hydrocarbons on the Lighting Value of Combustible Gas.*

[A paper read by Prof. W. Foster, at the 28th Annual General Meeting of the Incorporated Gas Institute.]

Whatever public knowledge there may be with reference to the lighting value of definite hydrocarbons, I believe it is largely, if not entirely, due to the labors of Dr. Percy Frankland. He has made experiments with three well known hydrocarbons, each of which is gaseous at ordinary temperatures, can be obtained in a fairly pure state without much difficulty in a well equipped laboratory, and is present in greater or less amount as one of the ordinary constituents of coal gas. The three substances examined were ethylene (C_2H_4), ethane (C_2H_6), and propane (C_3H_8). At about the same date, Mr. Lewis T. Wright made a few experiments with marsh gas (CH_4). I am not aware of any further experiments on the lighting value of these four, or any other, hydrocarbons. The determination of the lighting value of solid and liquid hydrocarbons has often been attempted; but as the methods employed are always indirect, I will refer to these subsequently.

A few weeks ago I obtained specimens of a fifth known hydrocarbon, named butylene (C_4H_8), containing 96 per cent. by volume of the pure substance. I hoped to put before the meeting some figures referring to the lighting value of this interesting substance, which could be taken without qualification. Unfortunately, I found my specimens, when prepared in bulk (between 4 and 5 cubic feet), contained 84.80 per cent. of butylene; of the paraffines, ethane and propane, 4.79 per cent.; and of air, 10.41 per cent. However, this mixture has been carefully examined photometrically and chemically. The following data were obtained; the gas being consumed in an improved Sugg's Argand burner, having a 7-inch by 1¾ inch chimney. It was not possible to burn this gas with any flat flame burner in my possession at the time; and as the gas is not likely to be put on the market, most probably flat flame burners are not made as articles of trade for the consumption of such extremely rich gas.

Above 0° C., butylene is a gas. It is about twice as heavy as air, and burns with an intensely smoky flame. It is a member of the olefine series—a class of unsaturated hydrocarbons having ethylene (C_2H_4) as the lowest known member of the series. For some time past I have desired opportunities for ascertaining the lighting values of members of the olefine series; because I feel certain that such information will not only be useful in connection with the practice of carbureting, but will most likely assist us in considering some of the enigmas connected with the lighting values of gaseous mixtures. The following data have been obtained with this 84.8 per cent. specimen of butylene:

Date.	Gas used in C Ft. per Hour	Lighting Power in Sperm Candles.	Lighting Power per 5 C Ft. of Gas.	Lighting Power per 5 C. Ft. of Pure Butylene.
June 4—				
Temp., 65.5° F.; bar., 753 mm.	0.6250	12.2	97.5	—
June 6—				
Temp., 62.5° F.; bar., 757 mm.	0.6250	13.3	106.0	123
	0.6125	12.6	103.0	

The only member of the olefine series previously examined is ethylene. Dr. Percy Frankland gives 68.5 candles as the lighting value of this gas per 5 cubic feet per hour when consumed in a "London" Argand. Therefore the figures for butylene, as they stand, would seem to indicate that the lighting values of the olefines bear some simple relation to the number of atoms of carbon in the molecule; butylene having double the number of carbon atoms, and almost twice the lighting value. This is in agreement with Frankland's observations of the two corresponding paraffines, ethane and propane. He found that 5 cubic feet of ethane (C_2H_6) gave a light of 35 candles; while 5 cubic feet of the higher paraffine, propane (C_3H_8), gave a light of 54 candles—an increase in the number of atoms in the molecule by one-half being attended with an increase in lighting value of one-half.

The subject is one which needs very careful treatment; for if Frankland's observations with the paraffines—and I have practically confirmed them with reference to the two olefines, ethylene and butylene—are to hold, how is it that marsh gas (CH_4), the first of the paraffines, has not a lighting value of one half that of ethane—namely, 17.5 candles? Mr. Lewis Wright gives the lighting value of marsh gas as 5 candles per 5 cubic feet; and everyone acquainted with its lighting value knows how insignificant it is. Yet marsh gas has a value in luminous combustible gases which is material.

The following table shows the relationship of the five hydrocarbons referred to:

*Reprinted from the London *Journal*.

Paraffines.

Marsh gas (CH_4).....	5.0	candles per 5 c. f. per hour			(L. Wright).
Ethane (C_2H_6).....	35.0	"	"	"	(P. Frankland).
Propane (C_3H_8).....	54.0	"	"	"	"

Olefines.

Ethylene (C_2H_4).....	65.5	candles per 5 c. f. per hour			(P. Frankland).
Butylene (C_4H_8.....123.0		"	"	"	(Foster).

Other Hydrocarbons.

Naphthaline ($C_{10}H_8$)..933.0	(?)	candles per 5 cubic feet of vapor.			
Gasoline.....	163.5	"	"	"	"

The determination of the lighting values of such substances as those cited, by simply burning them in air in specified apparatus at given rates, yields results which are not open to any very serious criticism. I now come to the consideration of two bodies, one of which is a solid with a high boiling point, and the other a commercial liquid with a low boiling point. In each case we require some gas, combustible or otherwise, for conveying the hydrocarbon to the burner; and the result so obtained must be modified by the nature of the conveying medium. Dr. Frankland made a series of observations of the lighting value of ethylene when mixed separately, in varying proportions, with each of the three gases—marsh gas, hydrogen and carbonic oxide. The highest values were obtained with marsh gas, and the lowest with carbonic oxide. In other words, the determination of the lighting value of ethylene, as an enricher, is modified by the nature of the gas enriched, although it may be a combustible and non-luminous one. In the calculations I have made respecting the value of naphthaline and gasoline when burned in coal gas, I have assumed that the lighting values of these bodies are in simple proportion to the amount present. This is not strictly true; however, some information upon the point will appear in the concluding portion of this paper.

Naphthaline ($C_{10}H_8$) being a solid with a high boiling point, the determination of its lighting value, when consumed alone, is rendered an almost impossible task. The difficulty is still further increased by its extreme richness in carbon; the percentage amount of this element being 93.75. All our knowledge of the lighting value of this hydrocarbon is derived from observations of the lighting value of a combustible gas containing an observed weight of the vapor of naphthaline. The only quantitative experiments in which I have been connected are those which were made jointly with Mr. Dibdin for the Committee of The Gas Institute. We found that 5 lbs. of naphthaline were required to double the lighting value of the gas used—viz., so-called 16-candle gas. In arriving at this conclusion, we assumed that the gas we were using at the time would give a light of 14 candles, or 2.8 candles per cubic foot, when consumed in a flat-flame butner. Such a value had actually been obtained with some special flat-flame burners; but they were not used at the time by the Albo-Carbon Company. If, therefore, 5 lbs. of naphthaline doubles the lighting value of 1,000 cubic feet of gas, giving, by our assumption, 2.8 candles per cubic foot, this quantity of naphthaline has a value of 2,800 candles. What, then, is the volume of 5 lbs. of naphthaline when in the form of vapor? Air being the standard substance, the density of naphthaline is 4.4. One cubic foot of air at 62° Fahr. weighs (say) 0.076 lb. One cubic foot of naphthaline vapor, corrected for the same temperature, weighs $4.4 \times 0.076 = 0.3344$ lb. Therefore the 5 lbs. of naphthaline in the form of vapor occupy a volume of 15 cubic feet; and the lighting value of each cubic foot in the experiment becomes $2,800 \div 15 = 186$ candles, or 930 candles per 5 cubic feet. Expressed in another way, we may say that 1,000 cubic feet of gas, giving a light of 14 candles per 5 cubic feet in a good flat-flame burner, is increased in volume by 5 lbs. of naphthaline to 1,015 cubic feet, the lighting value of such carbureted gas being 28 candles per 5 cubic feet. (In the actual experiment no observation of the increase in volume is possible.) Expressing the same facts in the usual way, we see that 1½ per cent. by volume of naphthaline vapor suffices to double the illuminating power of our 16-candle coal gas, and that, therefore, the actual volume of such vapor of this hydrocarbon in our common gas must be excessively small, because of the known presence of several other light giving hydrocarbons. All these hydrocarbons, naphthaline included, do not amount to much more than 5 per cent. by volume of ordinary 16 candle gas. There is, therefore, no process for the estimation of naphthaline in coal gas likely to be based on the measurement of the volume which it occupies. However, it has the property of giving ten times its volume of carbonic acid on combustion in oxygen; and this might be utilized in a qualified way.

The experiments which I have made with commercial gasoline—now extensively used in London for carbureting combustible gas—were undertaken, in conjunction with Mr. Frank W. Clark, about two years ago. The sample used had a specific gravity of .661, and was not one specific hydrocarbon, but most probably a mixture of several, having boiling points not widely separated. The importance of this liquid to the gas engineer at the present time for enriching purposes is well known. We found that 1,000 cubic feet of coal gas drawn from the main of a London gas company, when charged with the vapor of 4.5 gallons of the gasoline, became 1,175 cubic feet. This new volume was found to have a lighting value of 32.4 candles per 5 cubic feet, or 6.48 candles per cubic foot, when consumed in a flat-flame burner taken at random from the burners in use at the works where the experiments were conducted. The same burner, when used in the works with uncarbureted gas, gave 9.4 candles per 5 cubic feet, or 1.88 candles per cubic foot.

Therefore, 100 cubic feet of the uncarbureted gas has a value of $1.88 \times 1,000 = 1,880$ candles, and 1,175 cubic feet of the carbureted gas has a value of $6.48 \times 1,175 = 7,614$ candles. From the consumer's point of view, he obtains four times the light by the use of this quantity of gasoline. The actual increase in candle power is $7,614 - 1,880 = 5,734$. If we assume the character of the liquid to be pure pentane (C_5H_{12})—and this assumption can only be approximately correct—we can calculate the volume of the vapor of 4.5 gallons of gasoline. The density of the vapor of pentane is 2.5 times that of air; and, therefore, one cubic foot weighs $0.076 \times 2.5 = 0.19$ lb. The weight of 4.5 gallons of gasoline of specific gravity $.661 = 29.745$ lbs.; and the volume, therefore, works out at 156 cubic feet. Taking the figures of the experiment—viz., 175 cubic feet—the average candle value for the 4.5 gallons of gasoline, in terms of a cubic foot of the vapor, is $5,734 \div 175 = 32.7$ candles. In other words, 5 cubic feet of gasoline vapor has a value, according to these figures, of 163.5 sperm candles. On the assumption that a gallon of gasoline gives 40 cubic feet of vapor having a lighting value of 32.7 candles per cubic foot, we obtain $40 \times 32.7 = 1,308$ candles as the value of this quantity. To raise 10,000 cubic feet of gas from 16 to 17 candles requires an addition, in candle value, of 2,000 candles. The quantity of gasoline to effect this will, therefore, be $2,000 \div 1,308 = 1.53$, or a little more than 1½ gallons.

Since these experiments were made, the demand for gasoline has led Mr. Clark to look afield. He informs me that he has been led to consider the use of different samples of carbureting liquids, and that he is now supplying in quantity a body which is not the same physically (and, most probably, is not quite the same chemically) as the sample on which I worked. Although I have had a sample submitted to me, I have not had time to examine it. One gallon of this is said to be sufficient to raise 9,000 cubic feet of coal gas from 16 to 17 candles. If the price of this class of liquid can be kept at the present figure, it appears to me that its use will rapidly extend. There is no question as to its utility and convenience.

I have personally made a series of photometric observations with mixtures of London common gas, and the sample of butylene previously

	Sugg's Improved Argand, 7 in. x 1¾ in. Chimney.		"London" Argand, 6 in. x 2 in. Chimney.		Foreign Argand.		Table-Top Burner, Flat Side to Disc.		Table-Top Burner, Edge to Disc.		Table-Top Burner, Mean Results of Flat and Edge.	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ordinary gas	17.5	.....	16.3	.....	13.5	.....	.....	.....	.....	.....	.....	.....
	16.8	.....	16.6	.....	.....	.....	15.7	.....	12.6	.....	14.1	.....
With 2 per cent. of enricher	19.3	1.8	17.8	1.5	15.6	2.1	No. 5, 18.1	2.4	15.4	2.8	16.7	2.6
" 4 " "	21.2	1.9	19.7	1.9	18.0	2.4	" 21.1	3.0	18.3	2.9	19.7	3.0
" 6 " "	21.9	0.7	21.5	1.8	18.5	0.5	" 24.7	3.6	20.3	2.0	22.5	2.8
" 8 " "	23.7	1.8	23.0	1.5	18.6	0.1	" 27.2	2.5	21.2	0.9	24.2	1.7
" 10 " "	24.6	0.9	23.5	0.5	20.6	2.0	No. 3, 29.7	2.5	22.9	1.7	26.3	2.1
" 12 " "	27.2	2.6	25.7	2.2	22.5	1.9	No. 4, 37.4	7.7	29.0	6.1	33.2	6.9
" 16 " "	36.4	9.2	27.5	1.8	23.8	1.3	" 41.2	3.8	30.0	1.0	35.6	2.4
							No. 3, 38.8	1.4	31.4	1.4	35.1	1.9

(1) Candles per 5 cubic feet per hour. (2) Difference in candles for 2 per cent.

referred to. The gas was stored in a 5 cubic feet holder, kindly lent me for the occasion by the South Metropolitan Gas Company, and was kept some days before use, without diminution of volume, under a pressure of one inch of water. The chemical composition and lighting value were determined, at the end of the experiments, with the mixtures described in the above table (see p. 39). Being a gas nearly twice as heavy as air, a device was adopted for effecting the proper admixture of the two gases, and also for keeping the specimen from being contaminated with common gas. The mixtures were stored in a second 10-feet holder. By opening, to a suitable degree, the taps connected with the two supplies, it was found possible to regulate the quantities needed while the mixing was taking place. A water seal prevented any possibility of back-flow.

The illuminating power of each of the various mixtures was determined by a number of burners arranged on a tap with rotating arms, an example of which is before you. It has enabled me to test the same sample of gas quickly by means of six burners, three of which were Argands and three flat flames. By a special device I have arranged for the determination of the lighting value of a flat-flame burner in two positions—viz., one in which the plane of the flame coincides with the plane of the disc of the photometer, and the other in which the plane of the flame is vertical, and at right angles to the disc of the photometer. The two positions are technically known as the "flat side" and the "edge," and are so marked in the table. The primary object of my inquiry was to ascertain the relation between the illuminating power and the quantity of substance used for enriching a specimen of combustible gas; and, by means of a series of observations, such as I now venture to lay before the Institute, to arrive at figures which would express such relation numerically. Although I have not attained my object, the information gained is interesting, and may possibly be useful to some. The three Argands were as follows: Sugg's improved Argand, with 7-inch by 1¾-inch chimney, "London" standard Argand (Referees), with 6-inch by 2-inch chimney; an Argand of foreign manufacture. The three flat-flame burners were Sugg's table-top, No. 5, No. 4, and No. 3, respectively.

On glancing at the table of results, the chief point which strikes one is the irregularity of the rise in illuminating power for equal increments of the carbureting agent; each burner giving erratic figures at some point or other in the series. That the varying results are not due to insufficient admixture of the rich and poor gas is, in a sense, shown by the irregularities of a particular burner, with a given mixture, not coinciding with those of another burner. At the present time I attach more importance to the results obtained with flat-flame burners than with Argands; and a comparison of the figures will show how well the flat flames come out. But in these observations I wish it to be understood that I consider the ordinary way of testing flat flames most unfair. The figures which I now submit speak more strongly than any words I could employ. It appears to me that if flat flames were tested in two positions, and an average of the results was taken as the lighting value of the flame, we should have figures which could be compared among themselves, which would more closely agree with the values given by good Argands, and (what is far more important) would express the lighting values enjoyed by the ordinary gas user.

I do not feel justified in drawing any very hard-and-fast conclusion from these experiments, more particularly because I have promised to give the Secretary of the Institution of Civil Engineers a paper on these matters during the coming winter season, for which purpose it will be necessary to supplement my experiments with others of a kindred nature. For all ordinary purposes, it would appear that the rule, or practice, of regarding the amount of light obtainable from a carbureted coal gas as being proportional to the amount of carbureting material, is not far away from the truth; and that with suitable flat-flame burners, used in both positions indicated in the paper (the mean results being taken as the illuminating values of the mixtures), we have a fairly regular proportion maintained. One cannot fail to be impressed with the very diverse numbers attributed by the experiments to a particular sample of gas. They distinctly indicate how careful one ought to be in stating what the illuminating power of a sample of gas is, unless one at the time gives the exact circumstances under which the observations were made. Then, and only then, can a correct estimate be formed.

In this paper, the following points appear fairly distinct. That the paraffine gases have a specific illuminating value of one-half, or thereabouts, of the olefines. The paraffines and the olefines are closely related in their physical properties, such as specific gravity and boiling point. All are found in oil and coal gases. As the paraffines and olefines are found in commercial liquids, and mainly constitute them, a mere statement of specific gravity and boiling point does not indicate their particular value as carbureting agents. A neglect of such facts explains the great diversity of opinion which exists with reference to the use of commercial liquids; such being identified by mere specific gravity and boiling point. The lighting values of flat flames should be given in the two directions, "flat" and "edge."

Discussion.

The President thought the members were all very much indebted to Professor Foster for the valuable paper that he had just read. He (the President) only feared that its length would operate against its being fully discussed. When the author had himself stated candidly that he had not had time to study the real results of his own figures, he could hardly complain if those who had only just heard them, were in a still more helpless position. He hoped, however, that, if the paper were not much discussed now, it would be thoroughly studied at home by all the members, when they had it in print.

Mr. W. A. Valon (Ramsgate) said Professor Foster's paper, when carefully read, would probably be very instructive; but, hearing it for the first time, he did not feel competent to discuss it. One remarkable point which appeared to stand out prominently was that the olefines seemed to have double the illuminating value of the paraffines; and if this were established, a good many of the members would have to revise their conclusions, and perhaps unlearn something of what they had learned. In regard to Professor Lewes's paper, it was much to be regretted that this gentleman was not able to be present, to answer a few questions which might have been put to him, and which would have enabled the discussion to proceed more profitably than it could now do. As it was, he could only offer a few remarks upon it. The matter was simplified by the manner in which the subject had been divided—the first method dealt with being the carbureting of gas by charging it with the vapor of volatile hydrocarbons; and he understood that Professor Foster agreed generally with Professor Lewes's conclusions on this point. He (Mr. Valon) must say that, so far as his own experiments went, all such methods were more or less failures; and one fact alone was almost enough to prove this beyond dispute—viz., that those who carbureted gas in that way were always afraid to mix the hydrocarbon with the gas before it was put into the holder, but introduced it as the gas left the holder, and went out into the district. Now, it appeared to him that what took place in an aggravated form in the gasholder, must also take place, though perhaps in a somewhat mitigated degree, in the passage of the gas from the holder to the consumer. Therefore, it seemed to him that, if satisfactory results were to be secured at the further end of the district, the gas must be over-carbureted at the works. How far this evil extended, he did not know; but, from all the experiments he had carried out, he had come to the conclusion that, as a general rule very little benefit was derived by carbureting gas directly in this way. The second division of the paper dealt with enriching gas by superheated hydrocarbons, which, under ordinary circumstances, would condense and form portions of the tar. This was the Dinsmore process, about which he need not stop to say anything. Then came the method of enriching a poor gas by highly-carbureted water gas; and this was a matter which he believed had not yet been studied in this country as it should be. The conditions had not yet occurred in England, as they had in America, rendering it absolutely necessary; but they ought to be considered carefully, if only with a view to meeting temporary emergencies, such as strikes, fogs, &c. He thought there must be yet a good deal to learn with regard to this third division: and he was glad to hear that it was being taken up in some large works which could afford to experiment with a view to solving difficulties, instead of leaving the work, as was too often the case, to be done by provincial gas companies. Professor Lewes had referred to one particular process—the Lowe—which seemed to have taken hold in this country, as it had in America, where it was very largely used; and, as far as his (Mr. Valon's) information went, it was certainly the best. He inspected the Van Steenbergh process when it was at work in England, and was very much fascinated with it. But he then pointed out what seemed to him might be a possible difficulty—viz., the lowering of temperature by continuous working; and he believed this had proved a difficulty which had not yet been removed. He should be inclined to adopt almost without question what Professor Lewes had said on this point; for he went into it very thoroughly, and almost lived on the works for a time. Reverting for a moment to the Lowe process, he had referred to the cost of a 25-candle gas by that process as 1s. 8d. per 1,000 cubic feet; but he (Mr. Valon) should think the price would be more like 2s. 8d. The oil was put down at 3½d. per gallon, which might be correct, just as it was correct to say the price of cannel was 50s. per ton; but there were other matters to be taken into consideration. Cannel was a material which

could be handled in precisely the same way as ordinary coal; but with oil a different set of conditions was introduced. There was nothing on the works to handle the oil with; and the mere price was not the only thing to look at. Cannel could be put into the retorts with the coal; but the oil could not. There must be storage, and means for manipulation; and the facilities for delivery had also to be considered. If the works were upon a canal, the oil might be brought up in a tank barge; but then there must be something into which to pump it. Then, of course, they had to arrange for its flow back again for the purposes of the works. Again, if it had to be brought by rail, the difficulties were increased; and still more if the works were some distance from a railway or a canal. So soon as oil came to be used in sufficient quantity to be worth talking about, they would have to remodel the works and set up new plant; and he thought probably the cost of this would be half as much as that of the existing works, if not even more. There was no doubt that the presence of carbon monoxide in the water gas was a great drawback; and though Professor Lewes said there was no legislation at present forbidding the sale of illuminating gas with this constituent, he (Mr. Valon) did not think, seeing how particular Parliament was to protect the public against a few grains of sulphur, that there would be much likelihood of gas with this dangerous element in it being allowed to be sold without restriction. With regard to the last part of the paper, he must say he agreed with Professor Lewes in thinking that Dr. Thorne had over-estimated the illuminating value of oil gas as made by the Tatham process; but for the other details of the experiments, as given by Dr. Thorne, he was willing to answer, because he saw many of them carried out, and was quite sure they were correct. He had no doubt that if this system could be brought into use, something might be made of it. He might be expected to have some bias in favor of it; but he would nevertheless add that, in calculating the cost, the same considerations must be borne in mind as those to which he had already alluded in the other case—viz., that they must not be misled into taking the cost of oil as against that of cannel as the sole factor. He believed they would soon be able to know something practical about the cost of oxygenating oil gas; for he had heard that works were being put up at Huddersfield for making oxygen for purification, and leaving margin sufficient to deal with the oxygenation of a certain quantity of oil gas.

Mr. Harrison Veevers (Dukinfield) suggested that the Council might see their way to provide a loan-apparatus such as that of which Professor Foster had been in need, for the purpose of conducting experiments which were of benefit to the whole profession. It came very hard on one gentleman to furnish such apparatus; and it did not look well to have to borrow from individuals.

Mr. W. H. Y. Webber (London) said that it was perfectly true, as Mr. Valon had remarked, that the price of oil was not the only factor to be taken into consideration in dealing with the question of oil gas as a carburetor; but this was an argument which, to some extent, cut both ways. In many respects oil was cheaper and easier to handle than coal, because it would run by itself where it was wanted. Anyone who wished to see how very easily, cleanly, safely, and comfortably oil gas might be made, could not do better than go and look at one of the Pintsch oil-gas works. He had inspected the last new one at the Great Northern Railway Station, at Holloway, the other day, and was much struck with the general neatness and cleanliness of the whole arrangement. Mr. Valon said that the light hydrocarbons for carbureting under the Maxim-Clark process were generally added after the gas left the holder, which was quite true; but the bare statement in that form might leave a wrong impression as to the peculiar advantage of that apparatus. It was intended to be a corrective at the last moment. It was not designed for carbureting the whole of the gas, putting it into a holder and keeping it there until it was wanted. But, he took it, it was intended to deal with the flow of gas on the spot; and the great difference between that process and the common run of carbureters (as to which Professor Lewes had so strikingly said that the Patent Office was "strewn with their tombstones") was that in this only a very little carbureting material was used. It was only a question of improving the illuminating power of 16-candle gas by about 1½ candles, which was a very different thing from making a gas so rich that it was likely to deposit; and he had heard from a very competent authority that, with the small proportion used, there was practically no deposit at all in the syphons. Every member who had the opportunity should try a few of these experiments on the use of oil as a carbureter on his own account; for it was a subject which required to be studied more closely than it had been hitherto. He had found no difficulty in making gas from oil; but the great point to bear in mind was to be sure one did make gas, and not merely a vaporous body which would be certain to come down in liquid form very shortly if it was put into the gas. Oil might be turned into vapor with fatal facility; it could be done in a moment. But it did not follow that it was gas; and unless it was an incondensable gas which was put into the coal gas, it would come down sooner or later, and would carry with it some of the best of the coal gas, so that the last state of that coal gas would be worse than the first. Whatever was used, whether a light volatile hydrocarbon or an oil which had to be first turned into a gaseous hydrocarbon by gasifying it with heat, the amount which was ultimately represented as gas was very nearly the same in all cases. If ordinary rectified oil was used, for every unit of weight one got about one half in the form of gas; for instance, taking two gallons as the unit, one gallon practically disappeared in the form of tar, soot, &c. This being the case, it seemed to him there was something to be said for taking the lighter stuff as the carbureter to begin with, if it could be obtained at anything like a price. He would recommend them all not to be content with what they could hear about these things, but by all means to make oil gas and hydrocarbon gas themselves, with anything they could get hold of at all suitable for the purpose, and then they would understand a good deal more about it than could be gleaned from hearsay.

Mr. A. Edwards (Taunton) said the question was, when they did know all about it, how much richer the gas companies would be. His impression was that he could produce illuminating gas from coal as cheaply as it could be made by any of the oil-gas processes. He found no difficulty in making 15 to 20 candle gas from coal, provided he could get a proper selection; and although there was not much made out of residuals in the West of England, the gas cost him practically 1½d. per candle. The point which had been mentioned, about the necessity of a separate plant for oil gas, had occurred to him; and he could not see that in small works there was any money to be made by the process. Gas companies, or most of them, carried on business in order to make money; though happily a few also devote themselves partly to carrying out experiments for the benefit of the rest. If they would be kind enough, at the conclusion of their experiments, to run out the figures, so that they might be criticized, everyone would be grateful.

Mr. C. Meiklejohn (Oldbury) asked if Professor Foster took any steps to ascertain the uniformity of the composition of the gas after the butylene was mixed with it. It seemed to him that, in adding so heavy a vapor as butylene, which was said to be twice the weight of air, to gas, which was lighter than air, there would be great difficulty in securing uniformity after it was mixed in the holder. He did not understand if the gas was burned immediately after passing through the water-vessel, or if it was stored; and, if so, how long. Possibly the discrepancy in the results might be due to insufficient mixture.

Mr. J. Braddock (Radcliffe) asked what standard was employed in testing. If the candle standard was used, it might, he said, account for the somewhat erratic figures given in the table.

Mr. H. Ashton Hill (Wallasey) thought that there was some difficulty in reconciling the figures given in Professor Lewes's paper as to the cost of enriching 16-candle gas. He gave 4d. per 1,000 cubic feet as the cost of enriching gas by cannel, bringing it from 16 up to 17½ candles. This came to 3s. 4d. or 3s. 6d. for 10,000 cubic feet. In his experience, he found he could enrich the same quantity of gas 4 candles for 3s. 9½d. This was a very considerable difference, which might perhaps be reconciled, but at all events it required consideration. He should like Professor Foster to give them the difference in illuminating power obtained by the Sugg improved Argand, as he understood that in one case it rose from 16.3 candles with the "London" Argand to 17.5 candles, and in another case from 16.6 to only 16.8 candles.

Professor Foster said these determinations were not made with the exactitude he should use if he were going to report to a local authority, when he should make a series of ten observations. In this case three turns of the meter were taken to represent the volume of gas used; and he made perhaps half a-dozen readings.

Mr. Hill said he understood, then, that these figures were not to be regarded as final. He did not think there was much practical importance in the difference observed between the flat part of the flame and the edge, because it was always understood that there was some 20 per cent. difference. They all knew that photometric results and commercial results were quite distinct things.

The President said the suggestion of Mr. Veevers was one which could be readily dealt with by the Council of the Institute when they met; and if they thought it of sufficient importance to adopt it, he had no doubt it would meet with the approval of the members. It did seem to him to be important to bear in mind that the cost of oil had not been ascertained until the cost of working had been added; and this meant, not simply providing pipes for the oil to flow in (which it would do with very little trouble), but also a considerable amount for storage, if car-

bureting with oil gas were attempted on a large scale. Notwithstanding what had been said about the Maxim-Clark process, the facts were now pretty clearly ascertained, that this process as employed at the South Metropolitan Gas Works did give reliable results, and that the 1½-candle gain sought to be obtained was substantially realized when the gas reached the consumer. The point in Professor Lewes's paper which would commend itself to everybody was the commercial summary, to which Mr. Edwards had referred. Of course, the figure of 4d. was one which might well be discussed. If it cost Professor Lewes 4d. for his cannel, it did not follow that it would cost this to everybody. He (the President) paid a great deal less to enrich his gas up to 20 candles than some of his friends did in the South. The point was the expense of cannel, as it could be purchased at any particular works, in comparison with other processes, the cost of which was given in the paper. Probably not everyone was interested in enrichment, because if the public were only entitled to have 15-candle gas, those who could supply themselves with coal from the nearest colliery which would yield this quality of gas, would never go to the trouble of enriching the gas, unless it were for the sake of enriching their own knowledge at the same time, by carrying out the experiments to which reference had been made. His own experiments in this direction were rather limited and crude—some of them being with the richer cannels, and some with oil; but he would not detain the meeting by alluding to them.

Professor Foster said it was a matter of very great regret that Professor Lewes was not present; and it was in no sense a detraction from the merits of his paper to say that it represented the work of a large number of individuals. Dr. Thorne's experiments on oil gas were scientifically of great value; and one could not help feeling that, if anything like the results claimed for that process could be realized, there was something in it. He was glad Mr. Valon appreciated the distinction between olefines and paraffines, because such mixtures as gasoline and the like, he believed, although he had had no actual experience, did vary greatly in illuminating value. Information occasionally filtered through to him which he did not always make use of; but he believed that many people had been trying to employ different liquids of all sorts and descriptions, as Mr. Webber had recommended. Results of very diverse character, and often most unexpected ones, were obtained. A distinguished chemist had a few weeks previously suggested the passage of a poor gas through tanks of gasoline to take out the lighter vapors which were objectionable in transit; and another gentleman, in the course of the same discussion, proposed the passing of a rich oil gas into the hydraulic main, although, of course, this oil gas was made from a substance containing scarcely any sulphur, and only a mere trace of any other impurities. With all deference to the eminent engineer and the distinguished chemist who made these suggestions, he thought they were both equally wrong. Each, of course, was entitled to his opinion; but they were absolutely divergent. The difference chemically between these two bodies, which were closely related, was not great, but the illuminating value differed very considerably. Mr. Valon, referring to the Dinsmore process, with which his (Professor Foster's) name had been connected, seemed to intimate that it was not really worth discussing; but he had never regarded it in this way. Whatever there might be in the process, which had for its object the raising of the gas-giving character of common coals, it was entitled to some consideration; and whatever the practical effect of the process might be in somewhat modified forms, he felt that there was something in it which had a scientific basis. He had been getting information about it from every possible quarter, and the consensus of testimony was that persons using it had at times obtained extraordinary results, but had never been able to maintain them. This seemed to show, not that it was a mere "fluke," but rather that they were as yet ignorant of the causes of failure. Of course, this did not alter the position. If it was not a process that could be put into the hands of ordinary individuals to work, it was not good enough for gas managers. But this question ought to be kept distinct: Was it based on any scientific fact which might lead to the hope that it might be improved? His figures showed very clearly that if paraffines could be converted into olefines, their illuminating value would be doubled. How far this could be realized in practice was, of course, another question; and that was a point he had not touched upon—he left it for the Dinsmore people to show. He could indorse Mr. Webber's remarks respecting the use of gasoline; and he did not think the engineers who were employing it would continue to do so if it were not useful. In reply to Mr. Meiklejohn, he might say that the butylene was chemically examined, and the 86.8 per cent. was completely absorbed by fuming sulphuric acid. It was therefore presumably not a paraffine. He had also tested it in the ordinary eudiometric way, and the carbon always came out 7 volumes of oxygen instead of 6; so that it was not a paraffine. The object of the experiment was to see the result of mixing a certain proportion of the enricher with coal gas. He hoped to get some simple arithmetical proportion by which one could determine how much would be required to give a particular increase of candle power, and the same rule to apply all round. This was most important information if they could get it; but in this he had not succeeded—the proportion not being so simple as he had hoped. The gas used was permanent, he believed, at all temperatures above freezing, and at atmospheric pressure. If it were squeezed two or three atmospheres no doubt it would condense. The mixture was going on all the time; so that he did not think there was any chance of stratification.

Mr. Meiklejohn said the point of his question was whether the mixture was stored; as he understood that it was not.

Professor Foster said that the object of the experiment was to ascertain the rule, not whether one could make the gas and sell it. The standards used were the Methven screen and the 10-candle standard made by Mr. Sugg for the special purpose of testing large overhead lights; but he could transfer it to an ordinary bar photometer. The Methven screen was, in fact, used in nearly all the experiments. He quite appreciated Mr. Ashton Hill's remark that there was no advantage in determining the exact value of a low gas flame, from a gas manager's point of view. But the light was certainly 20 per cent. greater from the flat of the flame than from the edge; and this was certainly a matter of some importance. They were not considering their obligation to the outside public, but estimating the lighting values of these mixtures; and a study of the figures would show that the average from a good flat-flame slit burner did not differ very seriously from that with an Argand. He had only, in conclusion, to express his obligation to the South Metropolitan Gas Company and other friends who had assisted him in making the experiments.

On the Influence of Variations in Air upon the Lighting Power of Flames.

Dr. H. Bunte, in the *Journal fuer Gasbeleuchtung*, recently discussed this question at great length. A summary of his views is appended:

Messrs. Hefner Alteneck and Methven have shown that the lighting power of flames is greatly affected by a diminished proportion of oxygen, or an increased proportion of carbonic acid or moisture, in the air supply. The author has shown that flames go out when they have so far impoverished and vitiated the air that it contains 6 per cent. of carbonic acid. With the aid of his assistant, Dr. Burschell, he has now gone into the influence of these variations on the lighting power.

The most important variations are those in carbonic acid and moisture; either by direct mixture of these with air, or by their production at the expense of its oxygen, either separately or together, according to the circumstances of the experiment. The gas flames employed were those of a slit and an Argand burner. Hefner lamps and candles shorten their flames also, which complicates the matter; and in candles the melting of the candles is also affected, and the volatilization of the melted material, so that the candles have not been experimented upon, because the results are not measurable. Two flames, one in fresh air, the other in vitiated air, were compared. The flame to be tested was surrounded by a glass cylinder with diaphragms above and below; the position of these was regulated until the combustion was as in the open air, and the lighting power the same as that of the normal flame. The variously vitiated air supply is introduced into the cylinder. A free-burning flame gives much the same light without the chimney as with it; the absorption by one side is about made up for by reflexion from the other. Details are given as to the mode of regulation, etc.

The moisture of the air may be increased from 40° at 16° C. (= 0.72 per cent. by volume of water vapor) to 60° to 80° (= 2.3 volume per cent. H_2O vapor), without sensibly affecting the luminosity of the flame; but beyond this there was a fall in the luminosity, which decreased to 88 per cent. when the air was so far charged with moisture that it began to appear cloudy in the cylinder. The influence of moisture on the lighting power is thus relatively small. Carbonic acid added to the air has the following effect on a slit burner: CO_2 1.10 per cent., diminution 7.2 per cent., or at the average rate of 6.5 per cent. of CO_2: 1.77, diminution 13.7 (= average 8.15); 2.15, diminution 18.3 (= average 8.52); CO_2 3.73, diminution 28.9 (= average 7.75); CO_2 4.44, diminution 31.2 (= average 7.03); CO_2 5.11 per cent., diminution 36.6 (= average 7.16 per cent. for each percentage of CO_2). Argand burners give falls of 12.4 per cent. for 2.24 per cent. of CO_2, of 15.9 for 2.94, of 22.0 and 25.2 for 3.87 and 4.37. When a Hefner lamp is employed, the diminution is

at first much less rapid, but suddenly increases at nearly 3½ per cent. of CO_2. When the moisture or carbonic acid owe their origin to the oxygen of the air, the concomitant impoverishment in oxygen causes different results from the preceding. Diminution in oxygen caused by burning hydrogen in the air has a diminishing effect, thus: Slit burner, oxygen less by 0.40 per cent. of the whole air, light diminished by 5.2 per cent.; oxygen less by 0.49, 0.58, 0.70, 0.94, 1.21, 1.34, light correspondingly less by 9.8, 13.7, 17.1, 20.4, 28.8, and 30.4 per cent., respectively; Argand burner, oxygen less by 0.51, 0.71, 1.06, 1.45, 1.56, 1.70 per cent. by volume of the whole air, light correspondingly diminished by 7.0, 10.7, 14.3, 23.5, 26.5, and 32.4 per cent., respectively. Within these limits the presence of moisture produced from the hydrogen does not produce a great effect, except towards the end. Further experiment is requisite in order to determine the precise amount of this. When the oxygen is caused to be consumed by the combustion of coal gas, both moisture and carbonic acid are formed; and then a relatively small vitiation of the air causes a distinct diminution in the lighting power of the gas flame in the vitiated air. When the percentages of carbonic acid in the vitiated air are 0.26, 0.41, 0.49, 0.54, 0.60, and 0.65, the corresponding diminutions in the lighting power are 5.7, 9.4, 12.5, 15.0, 18.3, and 20.0 per cent., respectively, with a slit burner; while with an Argand burner, when the percentages of carbonic acid in the vitiated air are 0.18, 0.25, 0.37, 0.43, 0.56, and 0.68, the corresponding diminutions are 3.5, 6.5, 15.5, 17.2, 20.3, and 22.7 per cent., respectively. There is thus a great difference between the percentage of carbonic acid required to produce a given diminution in the lighting power when that gas is simply added to the air and when it is produced at the expense of the oxygen of the air.

An Alternating Current Motor.

Messrs. A. L. Kuehmsted and Henry Floy recently published the following report of the results of experiments made by them at Cornell University on an alternating current motor. The experimenters say:

The extensive introduction of the alternating current for electric lighting, and the flexibility of the system when used with transformers, have caused an imperative demand for an efficient and commercially convenient alternating motor.

For many purposes the synchronous type of motor would fulfill the above conditions if it were possible to put the same "in step" with its generator, without making use of some of the various but decidedly objectionable forms of "starting motors." With the idea of overcoming most of these objections, the authors constructed a 2-wire alternating motor, based upon a novel and unique theory, primarily suggested by Prof. H. J. Ryan.

It is a well known fact that should a motor have its armature wires closed on themselves, and one set of its fields excited by an alternating current differing by a quarter phase from another current exciting the other set of fields, rotation of the armature will ensue. Now, if instead of two currents, the same current excites both sets of fields, but the magnetization of one of the sets is caused to lag 90°, or approximately thereto, by means of mutual induction, we shall have conditions similar to the above case and hence a revolution of the armature.

For one motor, four horse-shoe magnets, A, B, C and D, each of 9 square inches face, were built up of tin plate to avoid Foucault currents. About two magnets, A and B, were wound, separately, 200 turns of No. 10 B and S insulated copper wire, which, when short-circuited on itself would, through metal induction with the existing coil, cause a lag of about 90 per cent. in the magnetization of its core. Insulated, instead of naked copper wire, was used for short-circuiting coils, in order that the electrical forces therein might be controlled and measured. The magnet C was then put on top of A, and D under B; about each of the two compound magnets thus formed were wound, in three sections, 290 turns of No. 10 B and S insulated copper wire to serve as exciting coils. The magnets were then placed facing one another, and secured to a cast iron base, the wires properly connected to binding posts, etc.

The most unique feature of our machine was its armature. This was simply a copper disc, 9 inches in diameter and one quarter of an inch thick; thus acting as a huge closed-coil copper conductor of one turn. The disc, supported by its shaft, was so placed between the poles of the two compound magnets, that the lines of magnetization between the poles of the same magnet would cut it.

The two compound magnets are only additive in effect. Considering only one of them, *i. e.*, A, C, the action is as follows: An alternating current cut through the exciting coils, sets up magnetization in both magnets, A and C. The magnetization in C is practically in unison with the current, while in A the magnetization lags nearly 90 per cent. behind that of C, because it is necessarily 90 per cent. behind its current, which is practically in unison with the magnetization of C. Thus the magnetization in one magnet is a maximum when the magnetization in the other is a minimum, and vice versa, the rate of change being, of course, greatest at its zero value. The copper disc being between the poles of both magnets, will have E. M. F.'s set up therein, due to the varying lines of induction.

If the magnetization of C is at its maximum, that of A will be zero, and the currents set up in the disc will be repelled by the maximum magnetization, thus causing the disc to revolve. At the next instant, when the magnetization of A is a maximum, that of C will be zero, but with its greatest rate of change, and in the same direction just had by the magnetization of A. Hence currents are induced in the disc in the same direction as before; but the magnetization of A being of the opposite sign, there will be an attraction, which will tend to drive the disc in the same direction as before. Thus continuous rotation is produced, and is due to rotating polarity of the field magnets.

The motor was first connected with the Westinghouse alternator, giving a constant current of 10 amperes. The disc was heated, but did not revolve.

By experiment it was found that the magnetization was arranged in the respective fields as theory dictated, but weak in the magnets enclosed by the short-circuited coils. This was remedied by putting in series with the coils a large resistance which brought up the magnetization, but even then the disc would not rotate. This showed that the fault was in the disc itself. By a series of computations it was found that the currents generated in the disc amounted to, perhaps, 100,000 amperes, which accounted for the rapid heating of the same. With such an enormous current the self-induction was so large as to counterbalance the effect produced by the fields. Substituting a copper disc $\frac{1}{32}$ of an inch in thickness for the original armature, rapid rotation was secured; but here further experiment had to end, owing to lack of time, leaving two variables to be "felt out." First, the exact thickness of the disc to secure best results. Second, the proper resistance in the short-circuiting coil to secure just the right magnetization in the magnet.

The Use of Air in Purifying Gas.

[Communicated by Mr. Norton H. Humphreys to the London *Journal*.]

Those who have followed the literature of this interesting subject will remember that at the 1888 meeting of the Gas Institute, in the course of a paper read by Mr. W. A. Valon, it was contended that air could not be used, even in so small a quantity as 2 per cent., at the inlet of the purifiers, without affecting the illuminating value of the gas to an important extent—such as 1 to 1½ candles. At the meeting held the following year, these experiments were again referred to; and several others were advanced as supporting them. It was also urged that oxygen supplied to the crude gas in a practically pure form was much more active than when supplied by means of air. It happened that the experience of the present writer did not agree with these conclusions; he having used air in the proportion of 1½ per cent. without appreciably lowering the illuminating power of the gas. Some particulars were given in the subsequent discussion; and he also suggested that, comparing a mixture of 0.5 per cent. of pure oxygen and 99.5 per cent. of crude gas, with one of 2.5 per cent. of air and 97.5 per cent. of crude gas, the only difference was that the latter contained 2 per cent. of nitrogen. And it was difficult to see how the presence of so small a proportion of nitrogen could affect the behavior of the oxygen one way or the other. He, therefore, while not disputing the accuracy of Mr. Valon's results and experiments, claimed that they could not be taken as of universal application, as it was possible, under some circumstauces, to employ air without any appreciable detriment to the illuminating value of gas.

In the course of his reply, Mr. Valon did not hesitate to reflect very strongly upon the statements thus advanced. He suggested that they would be "a dangerous weapon in the hands of the public if allowed to go forth;" that the object of discussion was to elicit the truth, and not to hide it; that the use of air as suggested was either an act of dishonesty or a waste of money; and that, as a matter of fact, it was impossible the statements could be correct. Notwithstanding Mr. Valon's apprehensions for the credit of the Institute and the safety of gas undertakings, the statements that were so objectionable to him were published; and so far they do not appear to have injured one or the other. More than that, the thing that was so vigorously denounced as impossible has been repeatedly substantiated by various gas engineers, and especially by Mr. Charles Hunt in his elaborate researches on the subject, as contributed to the Institution of Gas Engineers at their recent meeting. Now that

the matter has been not only discussed, but practiced to a sufficient extent to place it beyond question, there are a few points in connection with it to which attention may be directed.

No one has disputed the fact that if ordinary coal gas is taken and mixed with varying proportions of air, a noticeable depreciation is produced. This has been tried by several different observers; and the numerous published tables agree so nearly as to enable a general table, showing the diminution caused by each unit per cent. of air, to be easily compiled. Assuming the crude (instead of pure gas) to be taken, there appears no reason why such a table should not still hold good. In these cases, the air and gas are simply mixed in a holder; but when air is admitted as an aid in purification, the mixture passes through the purifiers, and various chemical changes, resulting in the removal of the oxygen, sulphureted hydrogen, and perhaps carbonic acid, obtain. If all the oxygen is not absorbed, the small proportion that remains is considered to be beneficial rather than otherwise; so that attention may be confined to the effect of the residual nitrogen on the illuminating power of the gas.

It may here be remarked that the plan of simply turning as much air into the gas as it will stand without showing loss of quality, while offering an easy way of applying this system, does not commend itself as the most efficient. No competent gas engineer will contend that any advantage can follow the use of an exorbitant quantity of air. All that is needed is sufficient to combine with the sulphureted hydrogen present, together with a moderate excess as practice may indicate. This cannot be arrived at unless there is a fairly accurate knowledge of the quantity of sulphureted hydrogen to be dealt with; and this can only be obtained by regular and periodical analysis of the crude gas, together with a knowledge of the properties of the various kinds of coal used in this respect. In all that he has written and said on this subject, the writer has had in view the use of a proper proportion of air, admitted through a meter, in such quantity as an actual knowledge of the work to be done may indicate. His experience has been confined to the removal of sulphureted hydrogen, as the coals with which he has to deal yield only a low proportion of carbonic acid and sulphur compounds. Lime being costly, and the used material valueless, it is cheaper to employ a little cannel to compensate for the former, and as the latter rarely rise above 10 grains per 100 cubic feet at the inlet of the purifiers, they do not here call for further attention.

In dealing with the illuminating power of the gas we supply, it is necessary to consider something further than the legal 5 cubic feet test. Not only must the gas pass this satisfactorily, but it must also pass the ordeal of the fishtails, batswings, atmospheric, and other burners used by the consumers. Although to a certain extent the examiner and the consumer run together, this is not necessarily so, and the engineer who is wise in his day and generation will do well, in these times of oil and electricity, to attend to what the consumers choose to say on this point. If complaints about the quality of the gas are frequent, he will cast about for a means of satisfying the public, rather than seek to shelter himself behind the official returns. A moderate increase of illuminating value is frequently a wise investment. If the use of air is attended with the disadvantages claimed by Mr. Valon, it may safely be assumed that the consumers would find them out, even if the photometer did not; and that complaints and dissatisfaction would prevail in the districts where air is used. Although the writer has had personal knowledge of the introduction of the air system in some ten or twelve districts, in no one case has it caused complaints from consumers. Nor is there any instance of it bringing about anything in the way of fines for deficient illuminating power.

The paper on "Purification" read at the recent meeting of the Institution of Gas Engineers by Mr. Charles Hunt, already referred to, goes a long way towards explaining the successful use of air. At the worst, Mr. Hunt shows that a unit per cent. of nitrogen means a loss of less than 0.25 candle power, or a very small percentage; and it accounts for the higher results previously returned by the custom of adjusting the consumption to 5 cubic feet per hour, which happens to be less favorable to the diluted gas. But the table of experiments on a practical scale shows even more favorable results; and points strongly to the existence of certain compensating influence attendant upon the use of air. In all but one of the experiments quoted, the loss of value in terms of each unit per cent. of air introduced was less than 0.5 per cent. In one, which included the use of 3.44 per cent. of air, the depreciating effect was practically *nil*. The existence or nature of these compensating causes has been neither positively proved nor disproved. We only know of them by the observed effect. The slight rise in temperature observed in the purifier has been referred to as productive of benefit, by preventing or hindering the absorption of illuminating hydrocarbons by the oxide. It will invariably be observed that the foul material, when air has been used, is much less "gasey" than when the reverse is the case, although it may have passed ten times as much gas. In dealing with this subject, it has been the rule to assume that the whole of the nitrogen remains in an inert state in the purified gas. But this has never been proved. The researches of some German chemists, recently published, show at least the possibility of an absorption of nitrogen in the oxide purifier. So it may be that a part of the so-called compensating influence is due to the fact that the actual percentage of nitrogen remaining in the crude gas is in reality lower than would be supposed.

The ordinary processes of purification do not take cognizance of the quantity of impurity to be removed. An *excess* of liquor, oxide, lime, &c., is used, and nobody knows much about what the extent of that excess may be. From a chemist's point of view, the use of air or oxygen is an interesting advance on this way of working. An endeavor is made to introduce these reagents in the exact proportion required, just as lime is applied for the softening of water. And it is obvious that, when any gaseous agent is used, this procedure must be followed, unless it happens that the agent is both cheap and not harmful to the gas. The real *crux* of the process will therefore depend upon the proportion of sulphureted hydrogen to be removed. At the inlet of the purifiers, after ample washing and scrubbing, this may be as low as 400 grains per 100 cubic feet. But introduce another kind of coal, and it may go up to 1,000 grains or more. The writer has made a large number of experiments on this point. A diagram showing the proportion of sulphureted hydrogen present in the gas at the inlet of the purifiers throughout a period of twelve months working was included in a paper read at the 1889 meeting of the Gas Institute. This and subsequent researches show that, with the same kinds of coal and methods of working, the proportion of this impurity present at this stage of the purification is fairly even. It rises or falls according to the quantity of gas made, in a regular ratio; and therefore, with the aid of the diagram above mentioned, the quantity present at any particular period can very readily be estimated.

The proportion of sulphureted hydrogen in the gas, and the bulk of gas passed through the purifiers per hour, determine the quantity of work to be done in a given time. A purifier 20 feet square, containing oxide equivalent to 2½ feet thickness, will hold 1,000 cubic feet of material. If we find that gas containing 600 grains of sulphureted hydrogen per 100 cubic feet passed through at the rate of 20,000 cubic feet per hour is completely purified, we have a removal of 120,000 grains per hour, equal to 120 grains per cubic foot of oxide. This factor of "grains per cubic foot of material per hour" will be directly influenced either by the quantity of gas passed, or by the proportion of impurity present in it. Gas engineers are accustomed to base their data on one of these only—the quantity of gas; neglecting the other, though it is of equal importance. And this neglect is responsible for a great deal of the confusion which arises when the purifying statistics at different gasworks are compared one with the other. The engineer who happens to have the lower proportion of impurities to deal with, receives credit for the supposed very efficient action of his apparatus; while, on the other hand, those who are troubled with high proportions of impurities are led to conceive unfavorable opinions respecting the particular forms of apparatus that they happen to use.

An Improvement in Gasometers.

On May 19th U. S. Letters Patent (No. 452,616) were granted to Mr. Frederick A. Sabbaton, of Troy, N. Y., for an improvement in gasometers. Following the words of the specification, the inventor says:

My present invention relates to improvements in such apparatus as are commonly used in works for producing and storing large quantities of illuminating gases for cities and villages; and the general object of my improvement is to provide such gasometers with means for temporarily storing in safety large and various quantities of naphtha, benzine, gasoline, or other hydrocarbon liquids which are lighter than water without materially lessening the capacity of the gasometers for storing gases and without exposing the liquid hydrocarbons to the gases in the gasometers.

In the drawing, Fig. 1 represents a central, vertical, section and elevation of a gasometer of a kind in common use in works for producing and storing illuminating gas, and furnished with one form of my invention; Fig. 2 is a plan of a part of the same below the line *z z* in Fig. 1.

A is the gasometer tank containing water, *B* and *C* is the gasholder having its open lower end in and sealed by the water in the tank and mounted so as to move upward and downward as the gas is introduced into and withdrawn from the holder.

D is a pipe or conduit furnished with means, as usual, for introducing carbureted gas into the gasholder, and *E* is a pipe or conduit through which the gas can be withdrawn from the holder; but the gas may be introduced into the gasholder and withdrawn therefrom through one and the same pipe or conduit *D* or *E* when furnished with suitable valves and connections, the same as in some well known gas works.

F is a reservoir for the hydrocarbon liquid, and is closed at its bottom, sides and top, is in the tank *A* and within the circuit of and covered by the gasholder *C*, and is directly surrounded and supported laterally on its outer surface by the water *B* in the tank. This reservoir, *F*, is shown as having in its upper portion a body of hydrocarbon liquid, *G*, floating upon the water, *H*, in the lower part of the reservoir.

To approximately equalize the liquid pressure against the inner and outer lateral surfaces of the reservoir *F*, and to keep or retain the hydrocarbon liquid or its upper portion in the upper part of that reservoir, whether much or little, or whatever quantity of the hydrocarbon liquid shall be in the reservoir, I furnish the latter with any suitable known passage or passages through which water will freely pass from the outer water tank *A* into the lower part of the closed stationary reservoir *F*, and from the lower part of interior of that reservoir into said water tank. For this purpose Fig. 1 shows in the lower part of the lateral casing of the

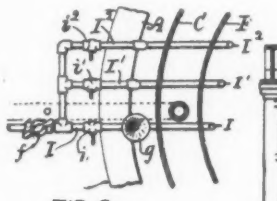

FIG. 2

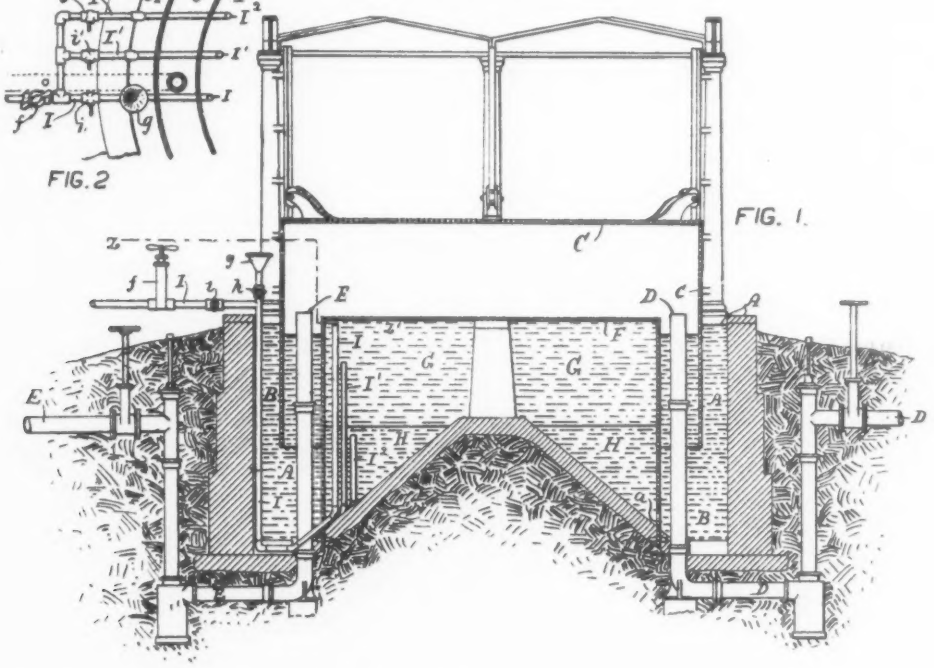

FIG. 1.

reservoir *F* an aperture or passage *a*, through which water will freely pass from the tank *A* into the reservoir *F* whenever the hydrocarbon liquid is being withdrawn from the reservoir, and the water will pass from the reservoir through the opening *a* into the tank whenever hydrocarbon liquid is being introduced into the reservoir, so that thereby the reservoir *F* is at all times automatically kept filled or nearly filled by the water and the hydrocarbon liquid floating on the water.

By having the passage *a* for the water to pass through from the tank *A* into the reservoir *F*, and from that reservoir into the tank *A*, the under surface of the hydrocarbon liquid in the reservoir is exposed to the same body of water to which the under side of the gas in the holder *C* is exposed.

I is a pipe or conduit open to and extending from the upper part of the interior of the closed reservoir *F* downward and outward below the lowest limit of movement of the gasholder *C*, and to outside of the gasholder and water tank *A*, so that through the pipe *I* hydrocarbon liquid can be introduced directly into and withdrawn from the upper part of the interior of said closed reservoir, while the water can simultaneously pass to and fro through the aforesaid open passage, as *a*, Fig. 1, between the lower part of the interior of the reservoir *F* and the outer tank. Fresh water might be introduced through the pipe *I* into the upper part of the reservoir *F*, whereupon the water would descend through the hydrocarbon liquid in that reservoir and simultaneously force out an equal quantity of water from the lower part of said reservoir into the surrounding tank. To facilitate the introduction of hydrocarbon liquid into the upper part of the chamber *F* and the withdrawal of the liquid hydrocarbon therefrom through the pipe or conduit *I*, the latter may be furnished with a pump *f*, elevated funnel *g*, and stop valves *h* and *i*.

To provide means for approximately ascertaining at any time the quantity and position of the hydrocarbon liquid *G* and of the surface of the water *H* in the reservoir, I have two, three or more pipes, as *I*, *I'*, *I²*, extending from outside the gasometer into the reservoir, with their inner ends fixed at certain different heights in the reservoir, as indicated in Fig. 1, and furnish each pipe with a stop valve, as *i*, *i'*, *i²*, and with a connection with one pump, *f*, as in Fig. 2, so that thereby whatever liquid or fluid in the reservoir *F* shall cover the open end of any one of those pipes can be drawn out through that pipe by the pump connected therewith

By having the closed stationary reservoir *F* in the water in the tank *A* and within the circuit of and covered by the gasholder *C* in that tank and furnished with an open passage, as *a*, Fig. 1, for water between said tank and the lower part of the interior of said closed reservoir and with a pipe, as *I*, extending from the upper part of the interior of said closed reservoir to outside of the said gasholder and water tank, as above described, the hydrocarbon liquid can be readily introduced into and withdrawn from said closed reservoir, however high or low may be the gasholder, and the hydrocarbon liquid in said closed reservoir is at all times thoroughly protected from exposure to the weather by the gasholder *C* and the body of water which seals the gasholder and immediately surrounds said reservoir in the tank, and that same body of water extends within said closed reservoir and thereby equalizes the fluid pressure against the opposite outer and inner lateral and top surfaces of said closed reservoir at all times, whether much, little, or no hydrocarbon liquid is in that reservoir, and whether the hydrocarbon liquid is or is not being introduced into or withdrawn therefrom.

I claim as my invention the combination, with the outer tank containing water, the gasholder sealed by the water in said tank and movable upward and downward therein, and means for introducing gas into and discharging it from said gasholder, of the stationary closed reservoir for hydrocarbon liquid immediately surrounded by the water in said tank and within the circuit of and covered by said gasholder, and having an open passage for water between said outer tank and the lower part of the interior of said stationary closed reservoir, and a conduit for hydrocarbon liquid extending from the upper part of the interior of said stationary closed reservoir to outside of the said gasholder and outer tank, substantially as described.

Production of Petroleum in the United States.

Mr. Joseph D. Weeks, of the U. S. Census Bureau, has submitted in Bulletin No. 76, a very interesting tabulation respecting the petroleum production of the country. An abstract of the Bulletin is appended:

In this preliminary statement the production of Pennsylvania and New York is united, the Bradford (Pennsylvania) and Allegheny (New York) fields being regarded as one in petroleum reports. Of the 21,486,403 barrels produced in Pennsylvania and New York in 1889, 7,158,362 barrels were produced in these two districts. The Bradford district lies

partly in Pennsylvania and partly in New York. The collection and shipment of its product by pipe lines is such that it is almost impossible to separate the quantity of oil produced in Pennsylvania from that produced in New York.

In the following table is shown the amount and value of the crude petroleum produced in the United States in 1889, according to the kind of oil and manner of consumption. Under the head "Lubricating" is included only the production of natural lubricating oils.

Amount and Value of Crude Petroleum Produced in the United States in 1889. (Barrels of 42 gallons.)

State.	Total.		Illuminating.		Lubricating.		Fuel.	
	Amount.	Value.	Amount.	Value.	Amount.	Value.	Amount.	Value.
Penn. and N. Y.	21,486,403	$23,493,449	21,393,160	$23,225,460	93,243	$267,989	.....	.....
Ohio	12,471,965	2,174,219	317,037	340,683	1,740	10,558	12,153,188	$1,822,978
West Virginia	358,269	379,643	345,369	344,868	12,900	34,775	.....	.....
Colorado	316,476	278,240	316,476	278,240	.....	.....	.....	.....
California	147,027	194,062	2,160	7,600	.....	.....	144,867	186,462
Indiana	32,758	21,293	.....	.....	.....	.....	32,758	21,293
Kentucky	5,400	5,400	5,400	5,400	.....	.....	.....	.....
Illinois	1,460	4,906	.....	.....	1,460	4,906	.....	.....
Kansas	500	2,500	.....	.....	500	2,500	.....	.....
Texas	48	340	.....	.....	48	340	.....	.....
Total	34,820,306	$26,554,052	22,379,602	$24,202,251	109,891	$321,068	12,330,813	$2,030,733

The production of petroleum in New York, Pennsylvania, Ohio, by districts, and West Virginia, so far as obtainable, was as follows: *Pennsylvania and New York:* Bradford district, Pa., and Allegheny County, N. Y., 7,158,363 barrels; Forest County, 258,955; Warren County, 2,347,434; Butler and Clarion Counties, etc., 5,358,403; Tidioute and Titusville, 885,119; Allegheny County, 541,092; Beaver County, 602,736; Washington County, 3,848,145; Greene County, 392,912; Franklin district, 64,244; Smith's Ferry district, 29,000. *Ohio:* Lima, 12,153,188 barrels; Macksburg, 317,037; Mecca and Belden, 1,740. *West Virginia:* Southwest, 284,269 barrels; Volcano, 71,500; Burning Springs, 2,500.

In the following table are consolidated the statistics of production of petroleum in the various states of the United States from the beginning of operations in these fields, so far as the same could be ascertained. According to these figures the total production of crude petroleum in the United States from 1859 to 1889, both years included, has been 407,975,503 barrels, of which 368,283,514 barrels came from New York and Pennsylvania. Up to 1875 the total production of petroleum recorded came from these two States. It is estimated, however, that in addition to the amount thus given 10,000,000 barrels ran to waste, for want of a market, in and prior to 1862, from the Pennsylvania fields; also a large amount from West Virginia and Tennessee.

Product of Crude Petroleum in the United States from 1859 *to* 1889. (Barrels of 42 gallons.)

Year.	Total.	Year.	Total.	Year.	Total.	Year.	Total.
1859	2,000	1863	2,611,309	1867	3,347,300	1871	5,205,234
1860	500,000	1864	2,116,109	1868	3,646,117	1872	6,293,194
1861	2,113,609	1865	2,497,700	1869	4,215,000	1873	9,893,786
1862	3,056,690	1866	3,597,700	1870	5,260,745	1874	10,926,645

Year.	Total. (a)	Pa. and N. Y.	Ohio.	W. Va.	Colorado.	California.	Ky. & Tenn.
1875	12,162,514	8,787,514	b200,000	b3,000,000	.....	b175,000	.....
1876	9,132,669	8,968,906	31,763	120,000	.....	12,000	.....
1877	13,350,363	13,135,475	29,888	172,000	.....	13,000	.....
1878	15,396,868	15,163,462	38,179	180,000	.....	15,228	.....
1879	19,914,146	19,685,176	29,112	180,000	.....	19,858	.....
1880	26,286,123	26,027,631	38,940	179,000	.....	40,552	.....
1881	27,661,238	27,376,599	33,867	151,000	.....	99,862	.....
1882	30,510,830	30,053,500	39,761	128,000	.....	128,636	c160,933
1883	23,449,633	23,128,389	47,632	126,000	.....	142,857	4,755
1884	24,218,438	23,772,209	90,081	90,000	.....	262,000	4,148
1885	21,847,205	20,776,041	650,000	91,000	.....	325,000	5,164
1886	28,064,841	25,798,000	1,782,970	102,000	.....	377,145	4,726
1887	28,278,866	22,356,193	5,018,015	145,000	76,295	678,572	4,791
1888	27,608,025	16,484,668	10,010,868	119,448	297,612	690,333	5,096
1889	34,820,306	21,486,403	12,471,965	358,269	316,476	147,027	5,400
	342,702,065	303,000,076	30,513,041	5,141,717	690,383	3,127,069	195,013

a. Included in the total are the following from States which produced in 1889 only: Indiana, 32,758 barrels; Illinois, 1,460 barrels; Kansas, 500 barrels; Texas, 48 barrels. *b.* Including all production prior to 1875. *c.* This includes all the petroleum produced in Kentucky and Tennessee prior to 1882.

The stocks of crude petroleum on hand Dec. 31, 1888 and 1889, in barrels of 42 gallons, were as follows:

Year.	Pa. and N.Y.	Ohio.	Colorado.	Kansas.	Illinois.	Texas.
Dec. 31, 1888	18,999,814	10,161,842	13,092	240	110	6
Dec. 31, 1889	11,562,594	14,415,997	36,034	150	100	48

The amount of petroleum and petroleum products, in gallons, exported in the years 1888, 1889, and 1890 was as follows:

Year.	Crude.	Naphtha.	Illuminating.	Lubricating.	Residuum.	Total.	Value.
1888	77,387,796	13,466,234	451,964,143	24,289,826	1,861,104	568,960,103	$47,649,345
1889	83,991,196	13,958,680	548,395,731	27,754,239	1,838,694	675,938,540	52,793,241
1890	95,365,765	12,406,586	547,542,569	31,886,146	1,828,900	689,029,966	51,656,677

The Thomson-Watt Meter.

[A Paper read by Mr. F. E. Smith before the California Electrical Society.]

The meter which I shall endeavor to explain to night is the Tompson-Watt meter, which consists practically of a combined electric motor and dynamo; the armatures of each being mounted upon the same shaft, and a registering train which indicates the number of revolutions made by the motor and dynamo.

The armature of the motor is of the drum pattern, and is composed of eight coils of very fine copper wire, connected in the usual manner, viz: the inside end of one coil connected to the outside end of the next, with a branch connection leading to a bar of the commutator.

The armature is entirely coreless, that is to say, it contains no iron whatever; the wire being wound over two fiber heads which are separated about one inch, leaving the entire inner portion of the armature open to the air.

Just above the armature and fastened to the shaft is a small straight bar commutator, upon which rest two small copper brushes; one of these brushes is connected directly to one side of the mains, the other brush is connected through a resistance of fine copper wire situated in the back of the meter to the other side of the mains—thus connecting the armature with its extra resistance directly across the main circuit, in the same manner that an incandescent lamp would be connected. Thus it will be seen that the armature of the meter is continually connected and in circuit, carrying an amount of current which is proportioned to the E. M. F. of the mains, divided by the resistance of the armature circuit, thereby causing the armature to play the part of a volt-meter.

The next step is to provide a meter which will work in conjunction with the volt-meter or armature; this is provided in the form of

field magnets, under whose influence the armature is made to rotate. These field coils are wound with very heavy wire, and are connected in series with one side of the mains which supply the lamps. They are, like the armatures, without cores or pole pieces, and are situated as you can see on either side of the armature, a great deal after the style of the T.-H. arc light dynamos.

It will be seen that in connecting the field coils as just described, the current flowing through them will be in proportion to the number of lamps burning, and when all the lamps are turned off there will be no current.

The turning on or off of lamps does not, however, have any effect on the armature, for, as before stated, the terminals of the armature are permanently connected, one to each side of the mains; consequently there is a given quantity of electricity constantly flowing through the armature circuit, but as the resistance of this circuit is very high, the quantity is very small, about $\frac{1}{100}$ of an ampere.

The operation of the meter is as follows: It is evident that if you pass an electric current through the armature circuit of an electric motor without any current through the field coils, there will of course be no motion to the armature. But if you pass the current of one incandescent lamp through the field, a weak magnetic field is created on each side of the armature, and consequently imparts to it a rotary motion, caused by the well-known laws of magnetic attraction and repulsion; if more lamps are put in circuit, more current will flow through the fields, thereby increasing the power and speed of the motor.

These meters are ordinarily used on alternating current circuits, but for convenience and simplicity I am going to ask you to ignore the alternating current proposition, and confine your thoughts to a direct current motor, which this meter motor practically is.

I have now described in a measure the motor connected with this meter. The dynamo is of the simplest possible form, viz., a flat copper disc mounted on the same shaft with the motor armature, and revolves between the poles of three permanent horse-shoe magnets, and is what is known as Faraday's disc. This practically constitutes a dynamo: it has no commutator, it delivers no current outside of itself, and the only part which it plays is the part of a retarding device, that is to say, furnishes a certain amount of work for the motor to do. When a motor is running idly, with no kind of work to do, and with as little friction as possible, the speed of the motor will be as the square of the current; that is to say, double the current and you quadruple the speed. This, of course, in an electric meter, would not do. The speed of the meter must be proportional to the amount of current passing through the meter. This proportional speed is effected in quite a novel manner. As before stated, the speed of the motor is as the square of the current; on the other hand, the power required to operate this miniature dynamo is as the square of the speed, thereby making a balance between the motor and dynamo, and making the speed proportional to the current.

I believe I have covered all points in this meter so far as its construction and operation are concerned, with the exception, perhaps, of its connection with the registering train which records the number of watt hours consumed by a consumer. It was the intention, I believe, of the inventor of this meter to adopt as slow a speed as possible, his main object in doing so being to decrease the wear and tear; and the meter is so arranged that the armature makes one revolution per watt hour; consequently, in burning a 60-watt lamp, that is, a lamp requiring 1.2 amperes and 50 volts, the meter makes one revolution per minute, or 60 revolutions per hour, which would give a reading of 60 watt hours. I quote from a pamphlet issued by the Thomson-Houston Company the following: "Among the many questions incidental to the introduction and wide adoption of electricity as a means of light and power, is the one of a standard or unit by which the quantity of energy supplied to the consumer may be measured; and as this unit is to be used as a basis in making charges, it is evident that both producer and consumer are especially interested in the determining of such a unit, and in a good understanding of its meaning and application."

The elements which may be measured are:

First. The volume of current, the unit of which is the ampere.

Second. The pressure, the unit of which is the volt.

Third. Time, the unit of which is the hour.

It has been proposed to measure by ampere hours, but this system leaves out the pressure, which is inevitably variable, and hence as important an element as the volume; therefore the system is incomplete.

It has also been proposed to measure by lamp hours, or candle power hours; but such a system is only applicable to electric lighting, and cannot be used for electric power or other forms of electric consumption.

It is evident that a perfect system of electrical measurement should take account of the total amount of energy consumed, and should depend not only upon the volume of current, but also upon the pressure at which the current is applied.

The basis of which a system is provided in a unit which is the produce of the two units of current and pressure, and which is termed a "volt-ampere," or "watt."

This will be understood from the following simple example: An incandescent lamp taking one-half an ampere of current, on a circuit having a pressure of 100 volts, or a lamp taking one ampere on a circuit having a pressure of 50 volts, would each be consuming 50 watts of energy, and this multiplied by the number of hours would give the total number of watt hours for any definite time.

The watt, then, is an accurate and complete unit of measurement, and is generally applicable to all forms of electrical consumption.

A watt of electrical energy corresponds to $\frac{1}{746}$ of a horse power of mechanical energy; hence, if a lamp or motor took energy equivalent to $\frac{1}{746}$ of a horse power for one hour, it might be said to take one "watt hour."

I have endeavored to make clear to you the construction and operation of the Thomson-Watt meter; whether or not I have done so, you alone will decide; if I have not, or if there are any special points that are not clearly understood by any of you, I hope you will feel at perfect liberty to ask any questions that you may desire, and if it is in my power to answer them, I will do so with the greatest of pleasure; the instrument is here at your disposal for examination.

I will close by thanking you for your attention and the honor you have bestowed upon me.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE residents of Boyle Heights (a suburb of Los Angeles, Cal.) have induced the Los Angeles Gas Light Company to extend its mains through their streets. Thirty names were appended to an agreement to take gas from the Company for a term of years, and the Company could not resist so eloquent an appeal.

THE Americus (Ga.) Illuminating and Power Company is putting in a complete new plant for the manufacture of gas.

THE authorities of Le Mars, Ia., have granted to J. H. Winchell the right to operate an electric lighting plant in that city.

ALDERMAN HUNTER recently introduced an ordinance in the Board of Aldermen of Kansas City, Mo., which seeks to make a very decided cut in the rates that may be charged for either gas or electric lighting. The ordinance is appended:

Section I.—No person, company or corporation furnishing gas to consumers in Kansas City, shall charge therefor to exceed the rate of $1.25 per 1,000 cubic feet for lighting purposes, and $1 per 1,000 feet for fuel purposes, and such persons, company or corporation shall, when required, supply separate gas meters to consumers to measure gas for said fuel purposes.

Section II.—No person, company or corporation furnishing electric light to consumers in Kansas City to exceed, for arc lights:

For each arc light to 10 P.M.....	$8.25	per month.
" " " to 12 "	11.25	"
" " " all night.....	17.25	"

The ordinance was referred to the Committee on Gas.

MR. A. J. WOODMAN, who for many years has acted as Manager of the Saco and Biddeford (Me.) Gas Light Company, has resigned. He will go into business on his own account.

UNDER the plan adopted this year for the public lighting of Santa Rosa, Cal., the following number of lights will be maintained: 30 arc lamps, of 2,000-candle power each, 100 gas lamps and 100 gasoline lamps. All lamps are to be lighted from dusk to 1 o'clock, A.M., "clear, moonlight nights excepted."

ABOUT a fortnight ago, as the result of a preliminary meeting of several prominent parties in the manufacturing line noted, the National Association of Gas and Electric Light Fixture Dealers was organized at Cincinnati.

A LOCAL item from St. Louis, under date of July 2d, says that the electric lighting situation there has reached the stage that might be denominated interesting. The Municipal Electric Light Company will not, it is thought, carry out its losing contract with the city, and it is probable that steps will have to be taken by the authorities to meet the

emergency. Superintendent Ayer, of the Municipal Company, is quoted as saying that the Company is losing $25 a lamp a year, or $50,000 in all, and that for that reason the Company is not overwhelmingly anxious to extend the system unless the city causes the contract to be amended so as to make it a paying one.

THE recommendation made by Mayor Beveridge, of Paterson, N. J., in his message to the Board of Aldermen, that some new method be adopted for lighting the Almshouse, has had good effect, in that the Committee on Charities and Correction decided a few days ago to report in favor of awarding the contract for lighting the institution buildings to the United Gas Improvement Company, which was the only bidder. The building is at present lighted with kerosene lamps, which not only give a very unsatisfactory light, but are very dangerous. Mr. William H. Rogers, who is the local agent in charge of the plant of the United Gas Improvement Company at Paterson, offered to supply gas to the building at the rate of $1.50 per 1,000 cubic feet. As the building is piped for gas it will take only a few days to put the fixtures in, but as the Gas Company's mains will have to be carried through Union and Redwood avenues to the Almshouse, some delay will be occasioned on this account. It has been determined to cut the gas off at the meter, at a fixed hour every night, in order, as Alderman Hartley put it, to "prevent the inmates of the institution from lighting the gas and blowing it out again, with the usual disastrous results."

AT an extra meeting of the City Council of Ashland, Neb., it was decided to remove the arc electric lights from the streets, on the ground that they were altogether too expensive. The proprietors of the Ashland Mill and Electric Light Company, who have been supplying the lights on public account, say that because of this action on the part of the city, they will discontinue the supply of incandescent electric lights to the stores and residences of the ordinary consumers, wherefore the inhabitants are in "quite a state of mind."

THE Chester Gas Company's works have been leased to the Delaware County Gas Company, the vote of the shareholders being practically unanimous in regard to the proposition.

WE do not think any confidence will have been violated or injury done to any one by the publication of the following extracts from a letter received last week by us from Mr. H. Wilkiemeyer:

"PORTSMOUTH, O., July 1st, 1891.

"To the Editor AMERICAN GAS LIGHT JOURNAL: My leaving here for Evansville, Ind., depending entirely upon the completion of the work I had in hand at the time I accepted the Superintendency of the Evansville plant, is the reason I have not written you before this. To-day I have finished all the most necessary and important work, and will leave here next Tuesday, July 7th. I am about to leave here feeling heartfelt regrets, and possibly had I known I had in my short stay here made so many genuine friends as now show themselves to me, I might have determined differently; yet I feel I can gain the respect of the people in the Indiana city * * *. The President and Board of Directors of the Portsmouth Gas and Electric Company are broad-minded men, who give every assistance to make life pleasant * * *."

THE Directors of the Aurora (Ills.) Gas Company have declared a dividend of 2½ per cent., and report that the business is in a most flourishing condition.

SOME days ago, Messrs. G. B. Cardwill, Morriss McDonald, I. G. Strunk and G. W. Smith were appointed a committee, on behalf of the Commercial Club, of New Albany, Ind., to visit Terre Haute, for the purpose of "investigating the fuel and illuminating gas supplied to the people of that city," and the gentlemen (having "investigated" the matter), handed in the following as the result of their labors:

"Directors of the Commercial Club—Gentlemen: Your Committee appointed for the purpose of visiting Terre Haute with the view of investigating the method of producing fuel gas, now in operation in that city, respectfully report that they have performed the duty imposed upon them to the best of their ability. They visited Terre Haute and spent some 24 hours there examining the appliances used in making and using fuel gas. They also talked with the Managers of the Company, with those controlling the plants for making the gas, and with many citizens of Terre Haute, who have been using fuel gas. The net result of this investigation is about as follows: Fuel and illuminating gas of good quality is furnished the people of Terre Haute at 35 cents per 1,000 feet, and the use of the gas is increasing rapidly. The fuel gas is made from crude oil, purchased from the Standard Oil Company. When the new Company established the price at 35 cents per 1,000, the old Company readily met the new Company's prices, and all gas is now sold in Terre Haute at 35 cents per 1,000. For illuminating purposes it seems to be quite equal to ordinary coal gas, and for cooking purposes it seems to be entirely successful. As for its value for heating purposes, we were not able to satisfy ourselves. With the thermometer flitting about 90° we had no opportunity to personally test its merits as a heater, but we are of the opinion that it cannot be successfully used in open fireplaces or furnaces. It can be used, however, in stoves especially prepared for it. The citizens of Terre Haute are full of praises for the new fuel and light. They were paying $1.50 for the coal gas and to obtain an equally useful substitute for 35 cents was, of course, a great gain to them. In addition, they are now free from the trouble and annoyance of ashes, soot and coal piles. The price at which this gas is furnished to the people of Terre Haute, however, seems to be low. It probably costs 35 cents to deliver it. Your Committee is confident that a gas in all respects equal to the coal gas now furnished the people in New Albany can be sold for 75 cents per 1,000 feet and then have a fair margin for profit."

ALL of which is certainly rich, in the most complete sense of the term. The committee "in some 24 hours" examined a complicated system of gas making and an intricate system of gas distribution, with such thoroughness and despatch as to enable them to arrive at a determination before the 25th hour of their labors was upon them! Of course we note the delicate and trying time they must have had with the thermometer "flitting about 90°," and realize that had it (the thermometer) been only "sinking about zero," the committee's labors would have been much more "exhaustive." In fact, one could hardly say what the result would be were the thermometric conditions a trifle more favorable. It is reassuring to know that the Terre Haute fuel gas can be "used in stoves especially prepared for it," although we submit the opinion that that is very much like advising that shoes can be made to fit the feet, whereas it might be a painful matter were the feet called upon to accommodate themselves to a misfit. The committee also seem satisfied that 35 cents is the probable cost to the manufacturer of delivering each 1,000 feet of gas at Terre Haute, and that this circumstance is a great boon to the residents. In the meantime, what must be the sensations of the capitalists who are furnishing the money with which Terre Haute's gas consumers are being "booned." Looking the report over carefully, one is naturally led to the conclusion that its prominent lesson is the very old one that the Terre Haute fuel gas concern does not expect to make much or any money by selling gas, but that it may—if the purse strings of its proprietors hold out—eventually recoup itself by a dicker of some sort or another with the owners of the old Terre Haute Gas Light Company.

THE University of Pennsylvania will enlarge the scope of its course in Electrical Engineering. According to the official announcement, "The requirements for admission to the course of electrical engineering and the work of the first and second years will be the same as for the course in mechanical engineering. In the third year the course will include physics with laboratory work, electrical measurement, practical electricity and telegraphy with laboratory work; mechanical engineering, including strength of materials, hydrostatics and hydraulics, measurement of power and work in the mechanical laboratory. In the fourth year in electrical engineering the course will continue the work of the third year, and in addition take up dynamo-electric machinery, accumulators, photometry, telephony, and testing of dynamos, motors, storage batteries, etc., etc."

THE management of the Coldwater (Mich.) Gas Company has reduced the selling rate (gross) to $2 per 1,000 cubic feet—a concession of 25 cents per 1,000.

THE *Californian* is our authority for the statement that experiments with a new fuel material, composed of equal parts of asphaltum and peat, are being carried on at the Belmos foundry, San Francisco. If these experiments are successful much good cannot fail to come of them, since asphaltum and peat deposits abound in the State.

THE total number of personal taxpayers on the San Francisco tax roll is 50,741, and only two assessments for more than $1,000,000 are recorded. Those are: San Francisco Gas Light Company, $1,407,070; Spring Valley Water Works, $2,451,127.

THE Cottage City (Mass.) Gas and Electric Lighting Company has succeeded to the properties and franchises of the Cottage City Gas Company.

EARLY this month a committee representing the laborers in the different gas works of Philadelphia waited upon the Director of Public Works (Mr. Windrim) to confer with him upon the subject of their hours of labor. Chief Park, who was in Mr. Windrim's office at the time the men called, took part in the talk which followed. The men said their hours were very long, the two gangs working each 12 hours, and they wanted to know whether something could not be done by which they could have the benefit of the Saturday half holiday. Director Windrim replied that he wanted to do everything that was possible for the laborers in the employ of the city, but under the circumstances in which the Department was placed he did not see what could be done. If the men stopped work on Saturday the city would be without gas, and the appropriations were so closely calculated that there were no funds with which to pay an extra force. As to an eight hour day, the Department could do nothing unless the men chose to organize themselves into three gangs, instead of the two in the present plan of working. This would involve an increase in the force and a consequent decrease in wages. This plan the men did not think very feasible. The Director said if they could suggest a plan which would be practicable he would be glad to co-operate with them. The conversation between the Director, the Chief and the men was an entirely amicable one and the Committee, on retiring, appeared to be satisfied that only the want of means prevented the change in their hours of work.

THE Coupons, due July 1st, on the bonds of the Colorado Springs Lowe Gas and Electric Light Company are payable at the First National Bank of Colorado Springs, the First National Bank of Denver, or the Chemical National Bank of New York.

THE sale of the plant of the Troy (N.Y.) Electric Light Company was made at the Troy court house, on the morning of the 1st inst. When Receiver John J. Cassin opened the sale there were present Anthony N. Brady, his attorney, R. A. Parmenter, and E. W. Douglas and George R. Dorman, attorneys for stockholders' of the Company who opposed the sale. Mr. Dorman read to the Receiver a notice to the effect that his client, Martin R. Mosher, had appealed to the General Term from the order of Justice Mayham, denying a stay in the case, and that if his appeal was successful, he would hold the purchaser liable for restitution of the property. Anthony N. Brady was the only bidder. He offered $90,000 and the property was sold to him for that amount. The purchase was made subject to first and second mortgage bonds of the Company, aggregating $74,000 and mortgages amounting to $7,500.

MR. WILLIAM HEPBURN, Chairman of the Fire, Water and Light Committee of Councils, Stratford, Canada, writes that he will receive proposals, for the public lighting of the city by electricity, up to noon of Wednesday next. The tenders are to be made on the basis of a three year contract, from November 1st, 1891, and the lighting table is for 250 nights per annum, from dusk until midnight. Bidders are to estimate on 70 arcs of 2,000 candle power each, or 100 arcs of 1,500 candles each.

IN accordance with the recommendation of the Board of Gas and Electric Light Commissioners, printed some weeks ago in the JOURNAL, the Chelsea (Mass.) Gas Company, on July 1st, put the following rate schedule in force: On all bills paid before the 15th of the month a rebate of 10 per cent. will be allowed from the gross price of $2 per 1,000.

ARTICLES of incorporation have been issued to the Consumers Gas Company, of New Bedford, Mass., which is capitalized in $15,000. The officers are: President, Eben C. Milliken; Treasurer, Charles H. Briggs.

AT the special election recently held at Wheeling, W. Va., to determine whether the city should issue bonds for the construction of an electric lighting plant, to be operated on municipal account, 3,825 votes were cast. Of these, 3,014 were in favor of the project, which will now be carried out at once.

MR. ALBERT WEBER, who was at one time Superintendent of the Consolidated Gas and Electric Light Company at Bath, Me., is dead.

THE Maxwell Brothers were finally successful in their attempt to secure a franchise for the operation of a gas and electric lighting plant at Beatrice, Nebraska. The franchise is to last for 21 years.

MR. GEORGE R. VAUGHAN, on behalf of the Houston (Texas) Gas Company, has appealed to the City Council for the payment of $260 on account of damages to the Company's gas mains caused by the negligence of the contractor who is constructing a sewerage system for the city.

THERE were but two bidders in the competition for the public lighting of Erie, Pa., for the ensuing year. The figures in the proposals were as follows: The Erie Gas Company offered to furnish gas lights at the rate of $16.50 each per annum, which is a concession of $3 per lamp from the last contract price. The Company will also light and extinguish the lamps for $3 each per year. The Erie County Light Company offered to maintain 152 arcs (the number at present in use) of 1,200 candle power each, at the rate of 33 cents per arc per night, and if the number of arcs be increased to 250 or over, the price per arc would be reduced to 30 cents. Both classes of lamps are to be kept in duty from dusk to daylight.

THE water gas annex of the New Bedford (Mass.) Gas and Electric Light Company will be in working order by October 15th. It will be capable of producing 300,000 cubic feet per day.

AT the annual meeting of the shareholders in the Rich Hill (Mo.) Water, Light and Fuel Company, the following officers were chosen President, John A. Kellar, of St. Louis, Mo.; Vice-President, Robert C. Massie; Secretary and Treasurer, E. E. Sykes; Directors, W. F. Tygard, R. C. Massie, F. D. Sanderson, Frank Cheverton and John A. Kellar. The Company supplies gas and electric light and water to the residents of Rich Hill, and is in a very flourishing condition.

WE are advised, by way of Aurora, Ills., that a new process of "making gas has been put in operation at Waukegan, Ills., by which that city is supplied with gas at 15 cents per 1,000 cubic feet. One half ton of coal by this process, it is claimed, will make 500,000 cubic feet of 18-candle power gas, all the smoke being consumed, and leaving only about 20 lbs. of stone and iron from the coal." What could the Honorable Mr. Stein have been thinking about, that he did not let us know something about this wonderful process when on his last visit to New York? Only 20 lbs. of stone and iron left from the baking of 1,000 lbs. of coal! Well! Well!

Lime Sulphate.

Mr. G. H. West, writing about this subject, says this substance is one of the most annoying and injurious of all those held in solution by water used for making steam. Some waters, especially those from limestone districts, contain it in such large quantities that its use in boilers becomes a real source of danger. The peculiarity about this substance is that the colder the water, the more of it will be held in solution, and this is not the case with a great number of substances which are soluble in water, for the higher the temperature, the more will be dissolved and held in suspension by the water. Water of ordinary temperature may hold as high as 7 per cent. of lime sulphate in solution, but when the temperature of the water is raised to the boiling point, a portion of it is precipitated, leaving about 0.5 of 1 per cent. still in solution. Then as the temperature of the water is raised, still more of the substance is precipitated, and this continues until a gauge pressure of 41 pounds has been reached, which gives a temperture of about 290°. At this point all the sulphate of lime has been precipitated. Many other scale-forming substances act in a similar manner.

This shows quite plainly that any temperature that can be produced by the use of exhaust steam would not be sufficient to cause the precipitation of all the substances which might be contained in the water. But the highest temperature that can practically be obtained from the use of exhaust steam would be about 250°; and this is far above the average practice, as to obtain this temperature a back pressure of about 14 pounds would be required, so it will be seen that the water still contains a sufficient amount of sulphate of lime and other matter to cause a perceptible amount of scale to form in the boiler. Most of the substances which go to form boiler scale follow a similar law in this respect, so that nearly all of them are precipitated from solution when the temperature reaches that point due the pressure of steam commonly carried, but in some cases even that is not sufficiently high to cause the total precipitation of all such matter, but the conversion of water into steam leaves these salts free, and as the water can hold no more in solution, they are precipitated in the form of granules or dust and kept in circulation in the water until they find an eddy and become deposited in some part of the boiler, or as the boiling ceases, the water still retaining its temperature, the sediment settles on the top of the tubes and on the boiler plates, from which place only a portion of it is dislodged when the boiling again takes place. Some of these substances when alone form a hard crystalline scale, while others are deposited as loose matter, and still other substances when they are deposited together combine and form a different kind of scale. As the greater proportion of these scale-forming substances are precipitated when the water is at a very high temperature, it would seem quite natural that they might be removed or prevented from entering the boiler by the use of a live steam heater. This it is asserted is the case where such devices are in use.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 Wall St., New York City.

July 13.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	93	94
Central	500,000	50	—	90
" Scrip	220,000	—	95	100
Equitable	4,000,000	100	118	120
" Bonds	1,000,000	—	106	108
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	118	121
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Standard Gas Co—				
Common Stock	5,000,000	100	—	48
Preferred	5,000,000	100	—	90
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	95	98
Citizens	1,200,000	20	—	85
" S. F. Bonds	320,000	1000	100	103
Fulton Municipal	3,000,000	100	115	120
" Bonds	300,000		100	105
Peoples	1,000,000	10	70	73
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	870,000	100	90	97
" Bonds (5's)	70,000	—	—	—
Nassau	1,000,000	25	134	—
" Ctfs	700,000	1000	98	100
Williamsburgh	1,000,000	50	110	112
" Bonds	1,000,000	—	108	112
Out of Town Gas Companies.				
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	87	—
2d " " "	3,000,000	1000	—	74
Bay State Gas Co.—				
Stock	5,000,000	50	56	—
Income Bonds	2,000,000	1000	95½	—
Buffalo Mutual, N. Y.	750,000	100	105	110
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
" " Bonds.	45,000	—	—	—
Chicago Gas Company.	25,000,000	100	50	50⅛
Chicago Gas Light. & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	90	91½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	97½
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	100
2d "	2,500,000	1000	—	100½
Consumers Gas Light Co., Jersey City	2,000,000	100	12	15
Bonds	600,000	1000	70	75
Cincinnati G. & C. Co.	6,500,000	100	207	209
Consumers Toronto	1,000,000	50	169	172
Central, S. F., Cal			90	—
Capital, Sacramento, Cal			58	
Consolidated, Balt.	11,000,000	100	44	—
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	110
Bonds	250,000		—	—
East River Gas Co., Long Island City	1,000,000	100	100	105
Bonds	500,000	100	100	102
Hartford, Conn	750,000	25	109	114
Jersey City	750,000	20	165	170

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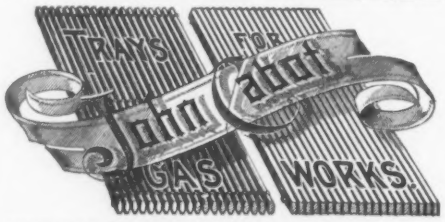

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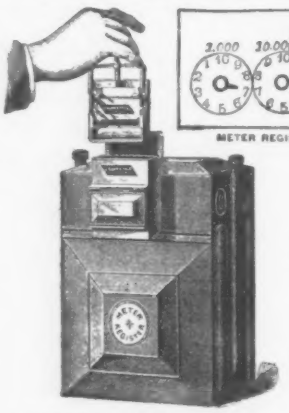

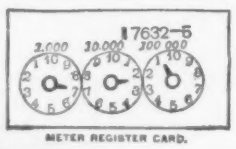

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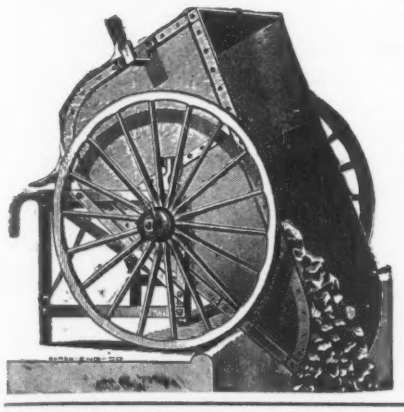

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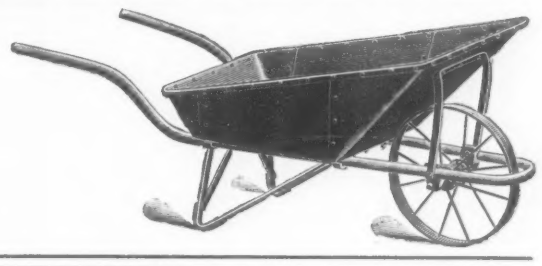

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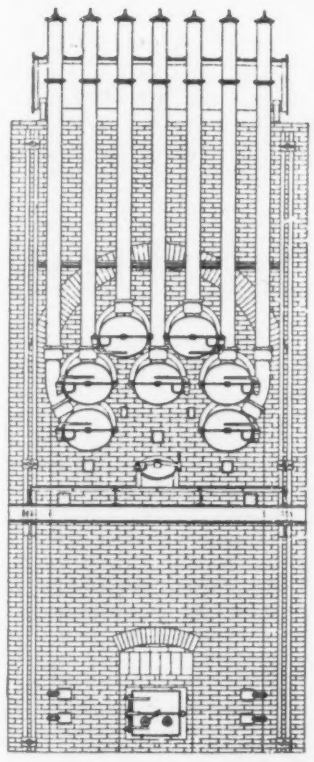

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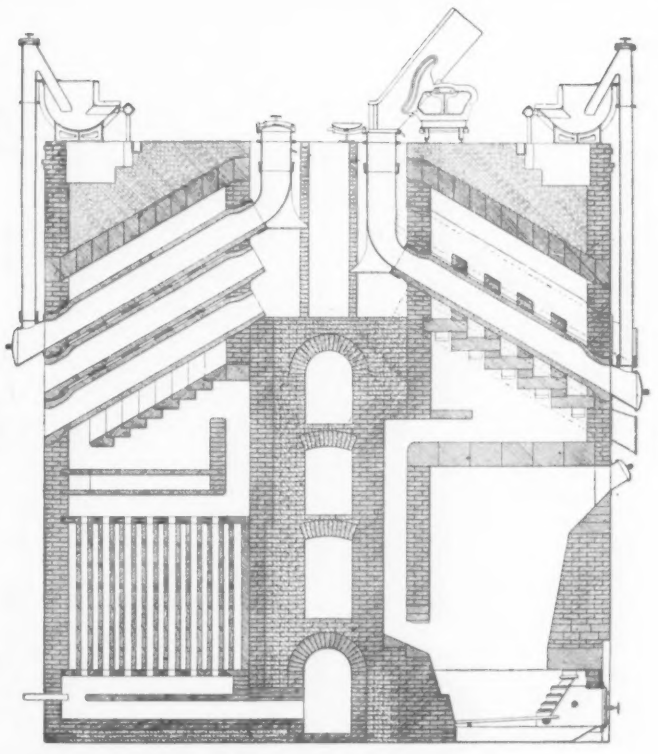

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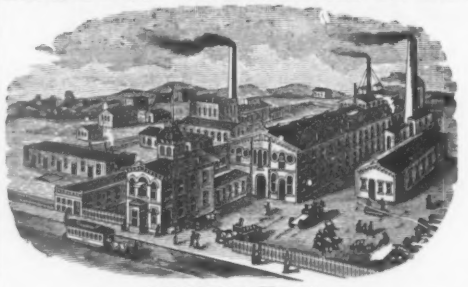

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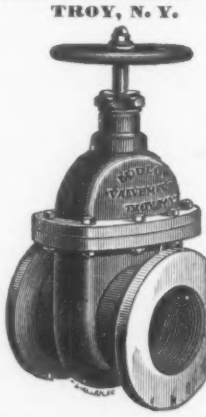

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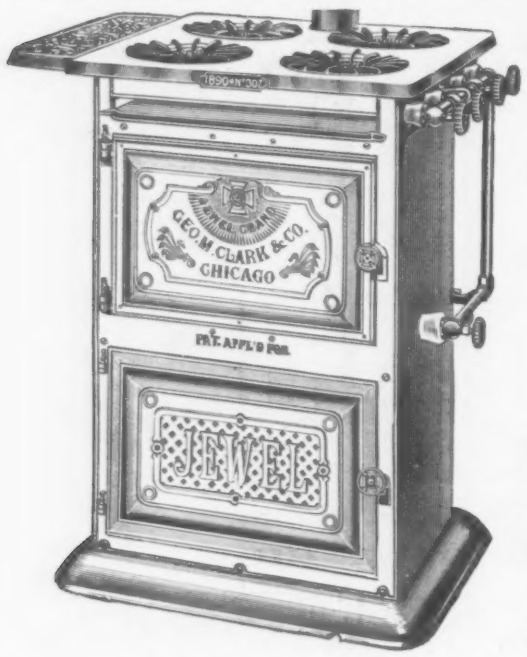

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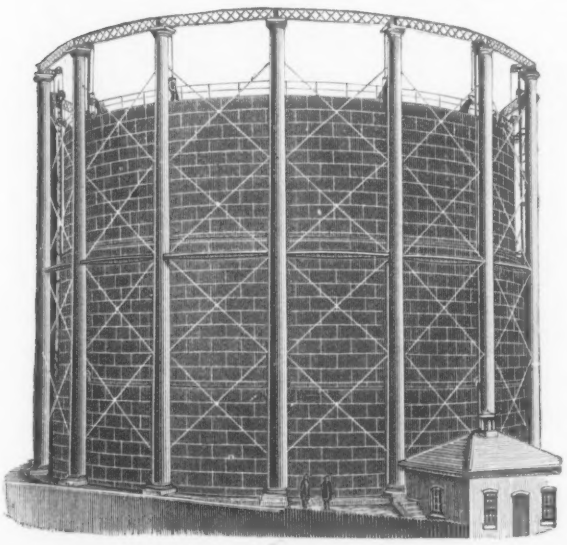

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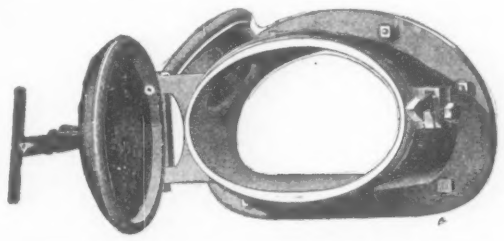

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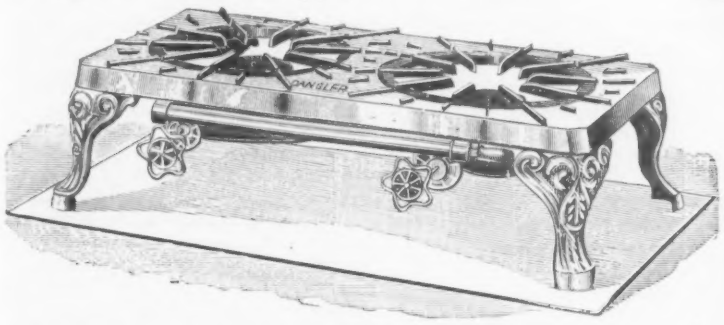

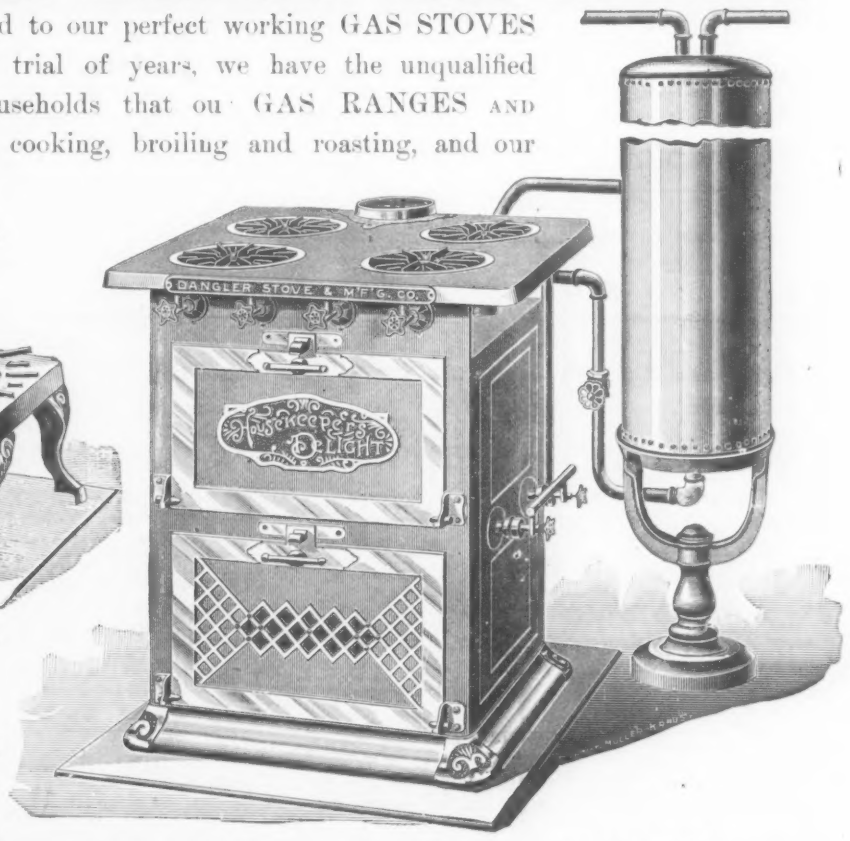

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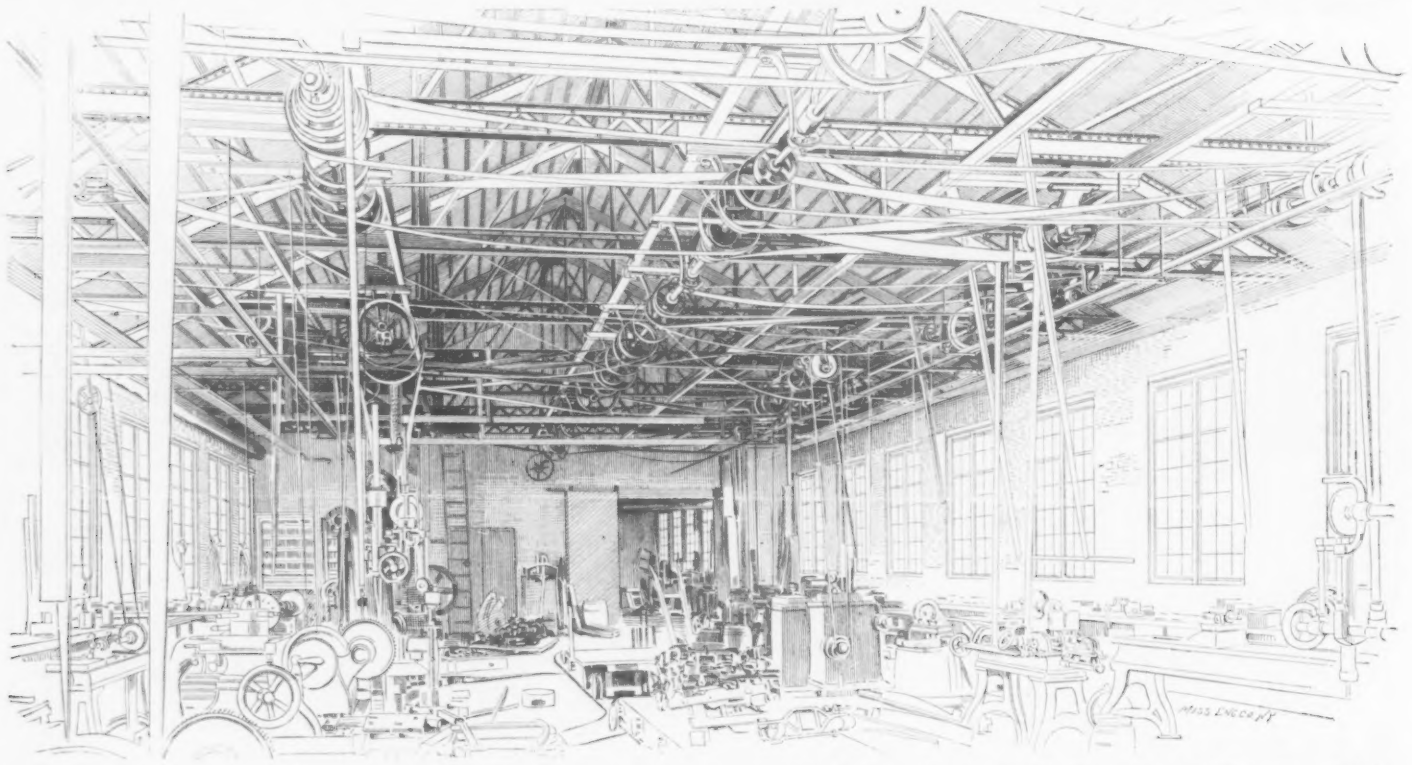

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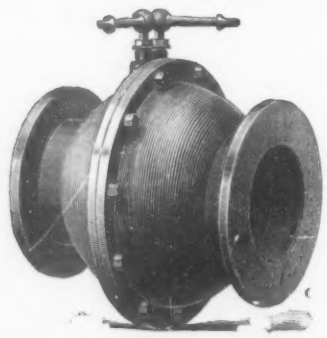

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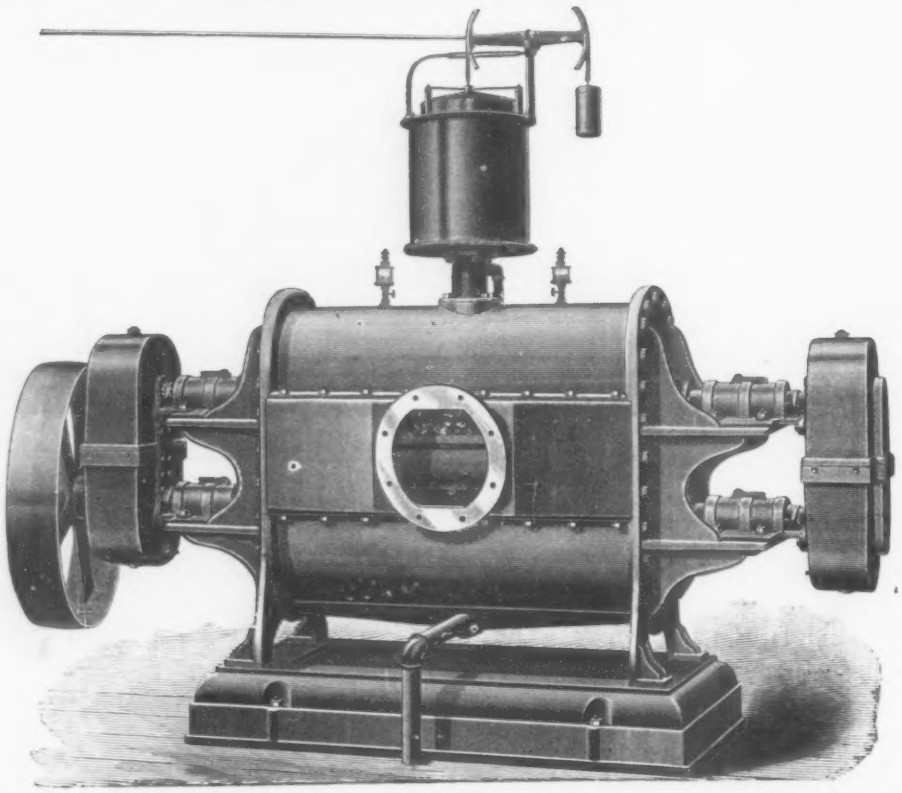

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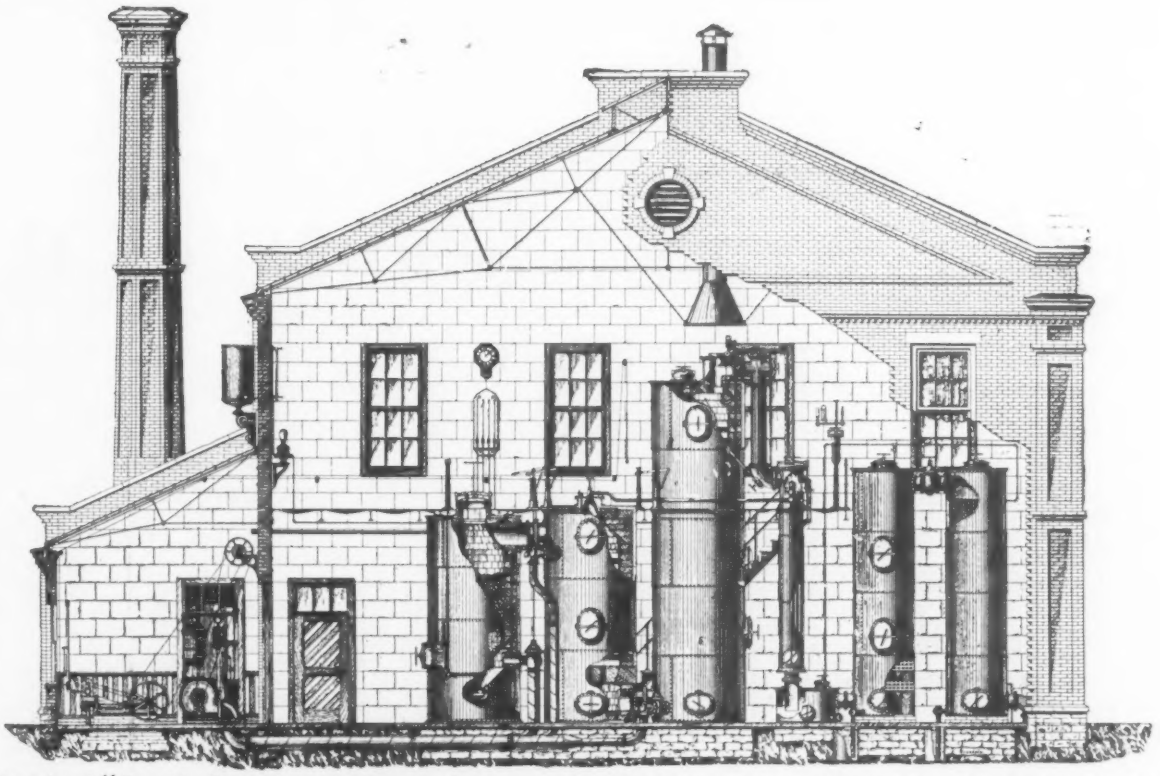

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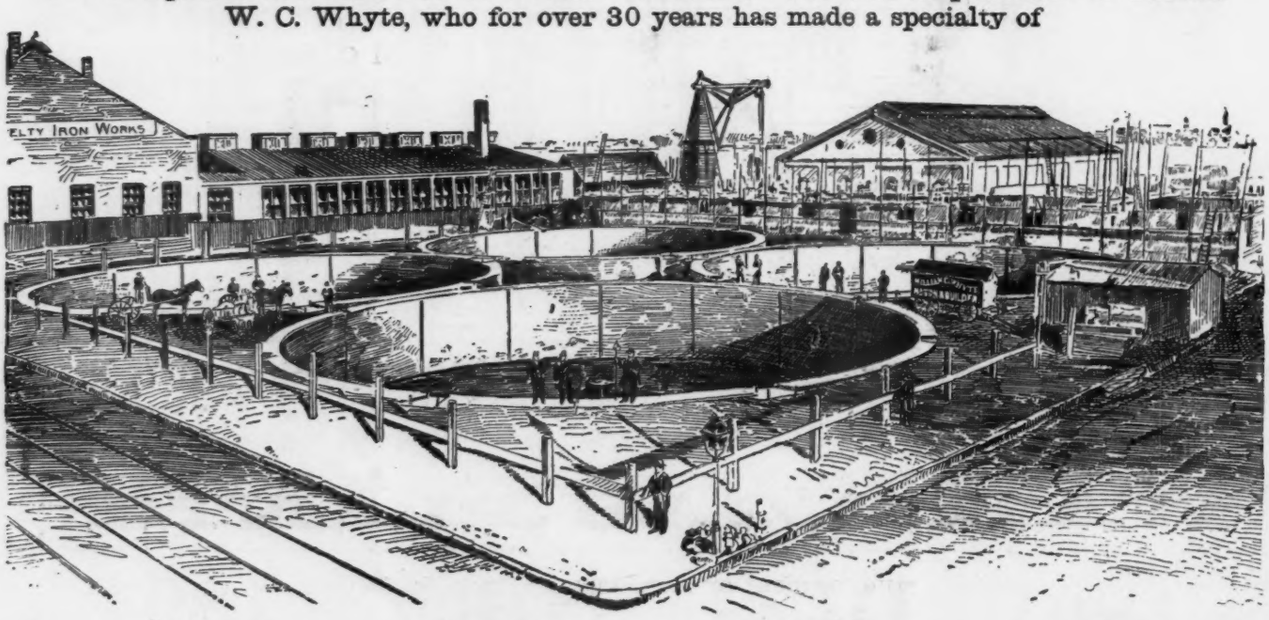

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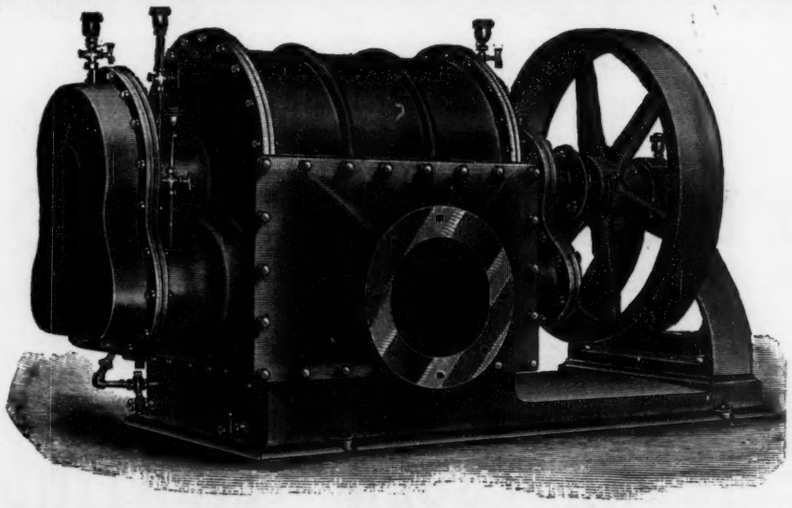

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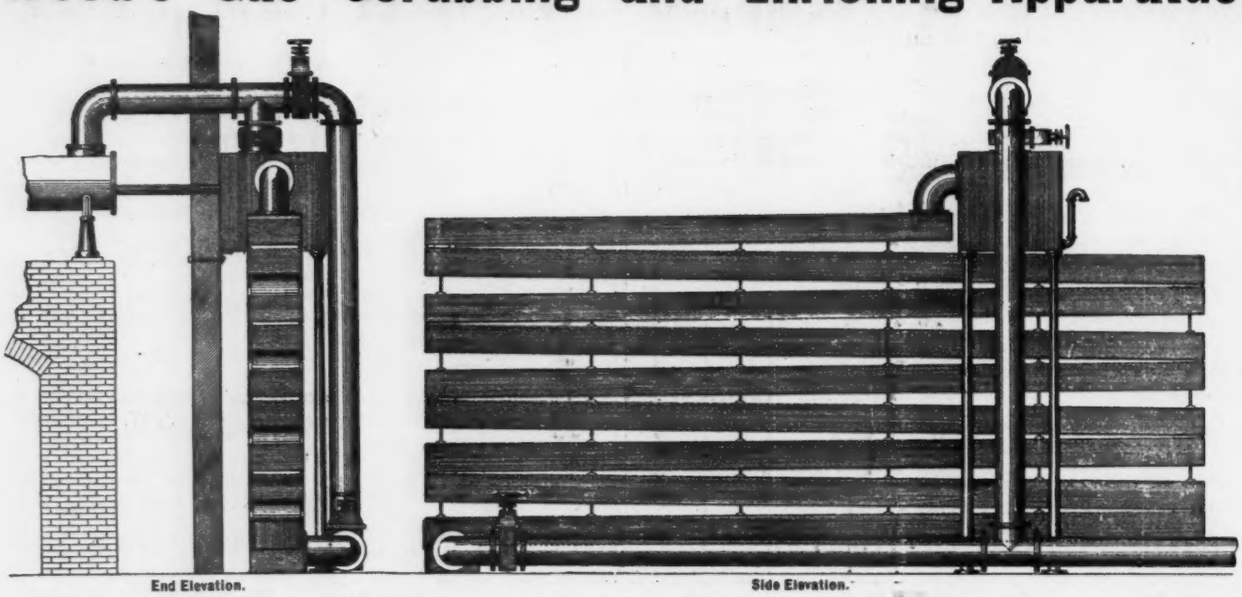

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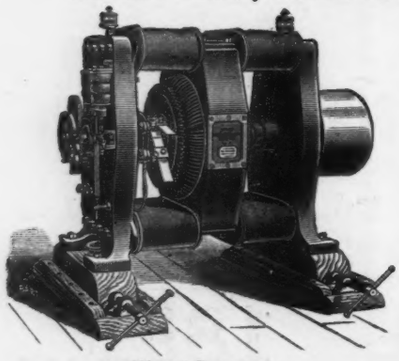

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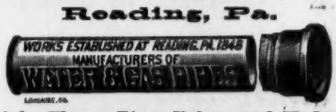

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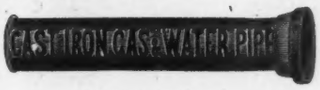

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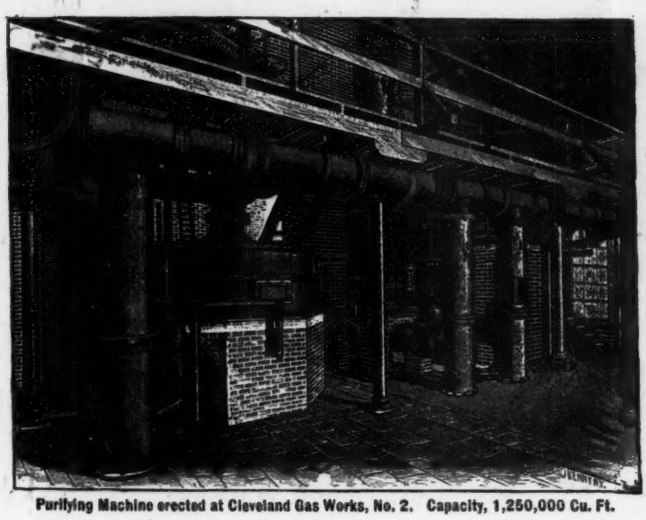

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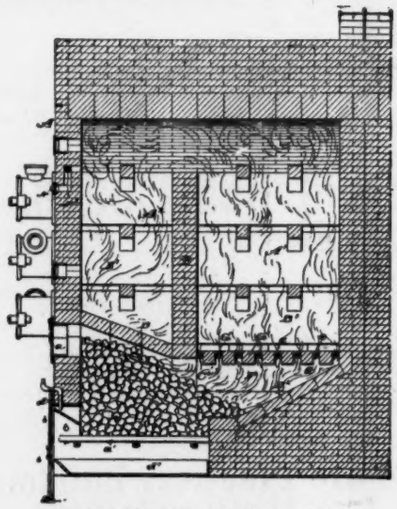

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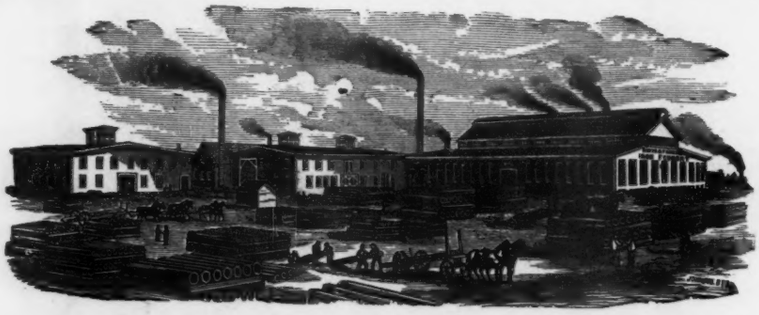

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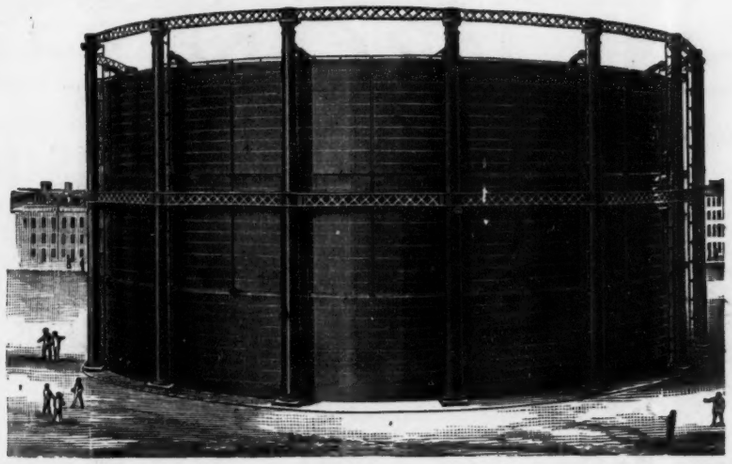

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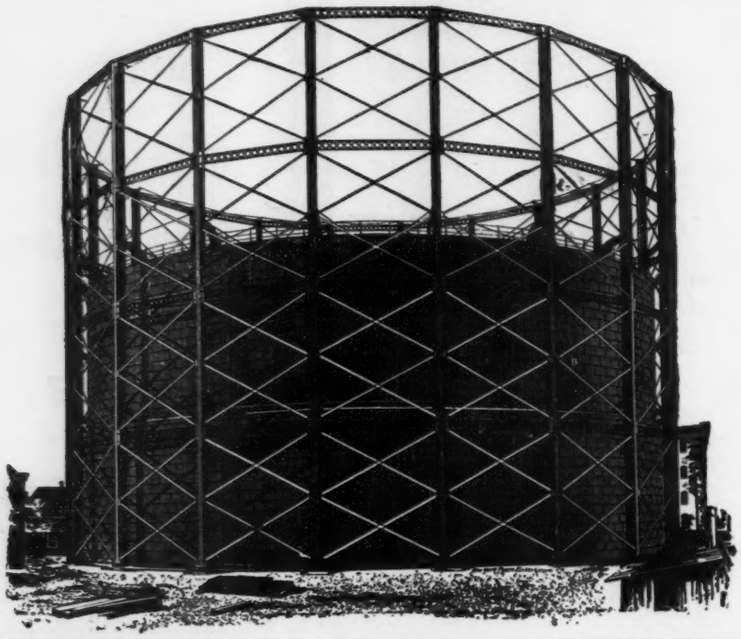

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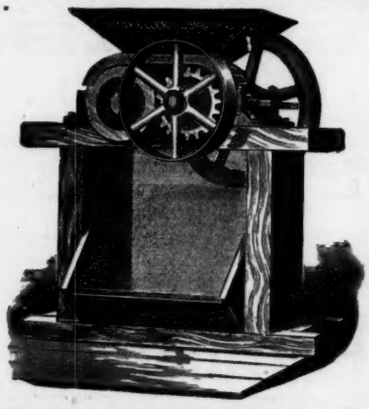

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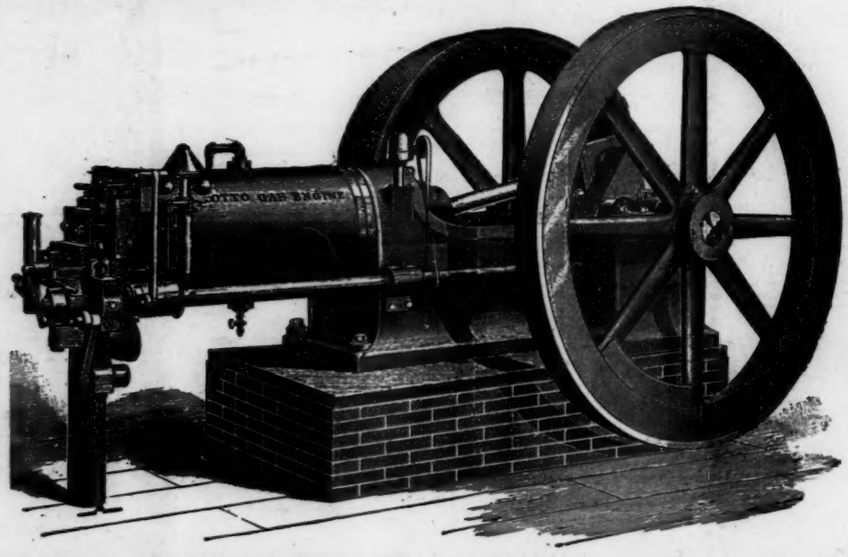

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